Data Consolidation and Importing Software for Microsoft Dynamics GP Performance Tests

by

Qiang Zhang

Bachelor of Science, Nanjing University

A Project

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

November 2006

This project document, submitted by Qiang Zhang in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisor under whom the work has been done and is hereby approved.

(Faculty Advisor)

This project document meets the standards for appearance, conforms to the style and format requirements of the Computer Science Department of the University of North Dakota, and is hereby approved.

Graduate Director

11/30/06

Date

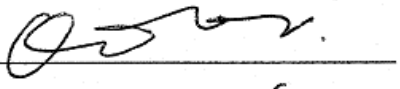
PERMISSION

Title: Data Consolidation and Importing Software for Microsoft Dynamic GP Performance Tests

Department: Department of Computer Science

Degree: Master of Science

In presenting this report in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that Department of Computer Science shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my work or, in his absence, by the Chairperson of the Department.

Signature 

Date 11-30-2006

TABLE OF CONTENTS

PERMISSION iii

TABLE OF CONTENTS iv

LIST OF FIGURES vi

LIST OF TABLES ix

ACKNOWLEDGMENTS x

ABSTRACT xi

CHAPTERS

I. INTRODUCTION 1

1.1 Significance 1

1.2 Objectives 2

1.3 Project Outline 3

1.4 Background Information 4

1.5 Report Organization 5

II. REQUIREMENTS AND SPECIFICATIONS 6

2.1 Requirements 6

2.2 Specifications 7

2.3 Format of Test Results 8

III. HIGH-LEVEL AND LOW-LEVEL DESIGN 12

3.1 System Architecture 12

3.2 Use Case Diagram 14

3.3 Data Flow Diagrams 15

3.4 User Interface Design 24

IV. IMPLEMENTATION 33

4.1 Class Diagrams 33

4.2 Data Models and Data Access 44

V. TESTING AND VERIFICATION 49

5.1 System Testing 49

5.2 Acceptance Testing 51

VI. CONCLUSION AND FUTURE WORK 57

REFERENCES 59

APPENDIX A 61

APPENDIX B 65

LIST OF FIGURES

Figure 1. Sample Folder Structure of XML Test Results 9

Figure 2. System Architecture 13

Figure 3. Use Case Diagram 15

Figure 4. Level-1 Data Flow Diagram 17

Figure 5. Level-2 Data Flow Diagram 18

Figure 6. Level-3 Data Flow Diagram: Process user input 20

Figure 7. Level-3 Data Flow Diagram: Parse test files 22

Figure 8. Level-3 Data Flow Diagram: Upload results 23

Figure 9. User Interface: Main Entry 25

Figure 10. User Interface: Radio Button Disabled 27

Figure 11. User Interface: Folder Browser Dialog 28

Figure 12. User Interface: Select Files in List 30

Figure 13. User Interface: File Viewer Example 31

Figure 14. User Interface: Message Box Example 32

Figure 15. Package-Level Class Diagram: Process User Input 34

Figure 16. Package-Level Class Diagram: Control Flow and Data Objects 34

Figure 17. Package-Level Class Diagram: Parse Test Files 35

Figure 18. Package-Level Class Diagram: Upload Results 35

Figure 19. Class-Level Class Diagram: ToolDataAccess 35

Figure 20. Class-Level Class Diagram: ToolHelper 36

Figure 21. Class-Level Class Diagram: DataTable_viewer 36

Figure 22. Class-Level Class Diagram: ApplicationSettings and ApplicationItem 37

Figure 23. Class-Level Class Diagram: StatusForm 37

Figure 24. Class-Level Class Diagram: UserInputs 38

Figure 25. Class-Level Class Diagram: ObjectXMLSeriaLizer 39

Figure 26. Class-Level Class Diagram: Driver 39

Figure 27. Class-Level Class Diagram: TestCaseCollection, TestCaseItem, MachineItem and Event 40

Figure 28. Class-Level Class Diagram: XMLTestFile, XMLTestItem and XMLEventItem 41

Figure 29. Class-Level Class Diagram: TxtTestFile, TxtTestItem and XMLSingleUserItem 42

Figure 30. Class-Level Class Diagram: IParser, XMLParser, TXTParser, LookUpTable and ParserHelper 43

Figure 31. Class-Level Class Diagram: Loader and LoaderDataAccess 44

Figure 32. Error Message for an Invalid User Input 50

Figure 33. Table Display for an Invalid Test Data 51

Figure 34. Table Display for Valid Test Data 54

Figure 35. Message Box After Processing 54

Figure 36. A Screenshot of ABench Webpage 55

Figure 37. A Screenshot of ABench Webpage 55

Figure 38. A Screenshot of ABench Webpage 56

Figure 39. User Interface: Select Application, OS and Tier 62

Figure 40. User Interface: Add or Select Build Number 63

Figure 41. User Interface: Select Action on Existing Build Number 63

Figure 42. User Interface: Enter Test Results Folder and Select Files 64

Figure 43. User Interface: Start Process 64

Figure 44. User Interface: Close the Software 64

LIST OF TABLES

Table 1. AllTestCaseLookUp Database Table..... 46

Table 2. AllTestCasePerfCounters Database Table..... 46

ACKNOWLEDGMENTS

I would like to express sincere thanks to the many people who have contributed to the completion of this study. I would like to thank Dr. Wen-Chen Hu for his support and guidance through the duration of this work. Many thanks to Shawn Hanson, Mark Dowell and Russ Brown, for their encouragement, advices and assistance on this project. Special thanks go to my family, for their constant love, understanding and many sacrifices, without which would have made this work impossible.

ABSTRACT

Data compatibility and presentation are always a major issue of computer science. This project was conducted at the Microsoft Corporation for a complex business application, Dynamics GP (formerly Microsoft Great Plains). It is a part of the efforts of publishing the performance test results of a project to a web-based reporting system, ABench. The proposed system tries to extract and process information from various sources and save the data into the ABench SQL database with minimal manual processing.

The proposed system is a database-driven, multi-tier windows application using C# and .NET. It includes four major components:

1. *Graphical user interface*: It lets users set up and run the system after entering necessary information.
2. *Configuration & verification unit*: It performs the following tasks:
   - Checks file availability, database connectivity, default application setting, etc.
   - Checks predefined data in database tables.
   - Launches the data parser.
3. *Data parser*: It includes two functions:
   - Parses and processes data.
   - Saves data by using a consistent format.

4. *Data loader*: It uploads the processed data to a database.

This project requires knowledge from both of the different performance testing results and the ABench SQL Server database. Many design/programming features are used to develop a generic tool such as dynamic instantiation. In addition to software design and development, the following tasks are also critical to this research:

- Design and implement algorithms for processing the raw testing data.
- Establish precise mappings from the test results to the data schemas and models used by ABench database.
- Design and implement a helper database for storing configuration information, lookup tables, etc.
- Implement an ABench website and database on a local machine for system development and testing.

CHAPTER I

INTRODUCTION

1.1 Significance

Performance testing is one of the most crucial steps in software development life cycle. It is used to test the run-time performance within the context of an integrated system. The application's features and transactions are tested and compared to measurable goals and objectives, such as response time from the server for a web based application. A final assessment report detailing executive summaries and pass/fail results is created for management to make decisions about the product release.

There are many different ways to go about performance testing, depending on the application type and test purpose. The tests are usually conducted by automated tools running against scripted test suites and test cases. Final test results are logged on local disks for further interpretation. These raw test results are organized in different ways depending on the testing tool. For a complex enterprise solution that normally have a family of applications, each application can have its own test tool, which will create test results in totally different form and data format. Because of the data inconsistency, creating and presenting compatible results are often a frustrating and time-consuming process.

This software engineering project was conducted at the Microsoft Corporation for a complex business solution, Dynamics GP, which consists of a variety of applications. Raw test results are stored in a plain text (TXT) format for some applications and an

XML format for others. Currently these raw data have to be converted to Excel spreadsheets for the management to interpret. The problems of this approach include:

1. With the amount of information generated in a given release, the number of spreadsheets to monitor becomes cumbersome and difficult to manage.
2. It requires great manual interference from the testers to convert the data.
3. The spreadsheets are difficult to read and interpret.
4. It is not easy to conduct comparisons between results and goals or previous test runs.
5. It is hard to communicate the results with other teams, as the format is unique to certain application type.

ABench, a web-based reporting website was chosen to be the achieving and publishing system for the performance testing team. It provides a uniform framework to for multiple projects, scenarios, test cases, performance metrics, execution tiers and baselines. This project is a part of the efforts of publishing the performance test results of different applications to ABench. It is also desirable that the project to be able to consolidate and process test results from other possible applications using similar formats.

1.2 Objectives

The primary objectives for this system are

1. To parse XML results and TXT results according to the application types and predefined configurations.
2. To process and save the parsed data into the remote ABench SQL database.

3. To build a tool that is adaptable to other applications that use similar output format.

1.3 Project Outline

The proposed system is a database-driven, multi-tier Windows application using C# and .NET programming. By integrating with ABench website, it is expected to solve the problems of data compatibility and presentation for performance testing data with minimal manual processing. After the implementation is completed, initial testing and debugging will be performed by the developers on the local system. The test team will then take the project for a satisfaction testing on the product system. Feedback from the test team will be collected to guide a second iteration of the software development life cycle.

This project requires knowledge from both of the various performance testing results and the ABench SQL Server database. Many design/programming features are used to develop a generic tool such as dynamic instantiation. In addition to software design and development, the following tasks are also critical for this research:

- Design and implement algorithms for processing the raw testing data.
- Establish precise mappings from the test results to the data schemas and models used in ABench database.
- Design and implement a helper database for storing configuration information, lookup tables, etc.
- Implement an ABench website and database on a local machine for system development and testing.

1.4 Background Information

Some background information about this research include:

- Microsoft Dynamics GP (formerly Microsoft Great Plains). Microsoft Dynamics GP is a comprehensive business-management solution built on the highly scalable and affordable platform of Microsoft technologies. It offers a cost-effective solution for managing and integrating finances, e-commerce, supply chain, manufacturing, project accounting, field service, customer relationships, and human resources [5].
- ABench website and database. ABench is a scalable and generic framework for archiving and displaying performance data. It is used by a variety of performance test teams. The front end provides several viewing options that range from high-level executive summaries to detailed charts and tables.

  . Performance results for various projects are reported using a standard format making it easy for teams and management read performance results. The database is hosted on a centrally located server using SQL Server. Users need to log on with Windows authentication to access the database. The database uses stored procedures to upload test results to the tables.
- .NET and C#. The .NET is a framework for programming on the Windows platform. Along with the .NET framework, C# is a language that has been designed from scratch to work with .NET, as well as take advantage of all the features provided by Visual Studio 2005, an object-oriented programming and development environment [6].

1.5 Report Organization

The organization of this report is as follows:

- Chapter II describes the requirements and specifications of this project.
- Chapter III contains high-level and low-level design.
- Chapter IV focuses on implementation of this project.
- Chapter V is testing and verification.
- Chapter VI includes conclusion and future directions.
- Appendix A includes the user manual.
- Source code is stored in the CD-Rom attached as Appendix B.

CHAPTER II

REQUIREMENTS AND SPECIFICATIONS

A requirement specification describes the user's needs of this system. It serves as an agreement between the end user and developer, it's viewed as a definition of what the implementation must achieve. The performance test team, as the end user of this system, provided requirements and specifications.

2.1 Requirements

The users have the following functional requirements for the data consolidation system:

1. Provide a unified method of processing test results. The results are processed by different tools depending on the application type in the current system.
2. Publish results to the ABench web system with minimal manual intervention. Only Excel spreadsheets are created for reporting in the current system.
3. The system should be adaptable to other applications that use similar output formats.

After integration with the ABench website, the whole system should achieve the following goals:

1. Displays results from performance test runs in an easy to read and interpret format.
2. Allows comparisons between results and goals or previous test runs.
3. Minimizes manual processing of raw data from test execution to publication.

4. Shows product performance over time.

The business justifications for this system are specified as follows:

1. Improved productivity for performance test team. In other words, the system should help the team to cover more tests.
2. Consistency in reporting for program team.
3. Single point of reference for all performance test results.

2.2 Specifications

The system specifications are discussed in the following list:

1. Input:
    - Be able to process TXT and XML performance test results.
    - Be able to specify application type, build number and testing environment information, such as operating system, data server, web server, etc.
    - The user must have the following two options according to the application type:
        a. Process all test results for a test run
        b. Select and process multiple test results
2. Output:
    - Upload processed results to ABench database. Must be able to view test reports on ABench website.
    - Report errors and warning messages during the process.
    - Create log file at the end of the process.
3. Security:

Must work within the constraints of an isolated environment. Performance tests are primarily run within their own networks, it is important that no interaction with outside domains be required.

4. Database:

   Any database schema and models designed for this system should be flexible enough to handle a wide variety of performance test types.

5. Data format:

   The data must be setup in a way that makes reporting from it easier than the current methods.

6. Interface:

   The interface must be easy to use and not cumbersome to set up. Implicit in this requirement is that the user should only have to specify a minimal amount of set up information each time results are imported.

7. System environments: The most popular environments are

   - Windows Server 2003 (Developer can also use Windows XP environment for development and testing)
   - .NET 2.0 framework
   - SQL Server 2005

2.3 Format of Test Results

As part of the input requirement for this system, the raw test results must be stored in a consistent agreed upon format, which includes folder structure, folder naming convention, and file structure. These files contain raw data that needs to be parsed and summarized into useful data.

2.3.1 XML Test Results

The test results should be stored in a two-level folder structure as shown in Figure 2. The parent folder is the physical location for this test run. The subfolder contains the XML test files for a certain scenario or module depending on the application type. The subfolder name should end with the number of users and the string "User" to indicate the user load. For example, the folder name "APTrx1User" means the scenario or module name tested is "APTrx", and only one user is simulated. If a folder name failed to follow the above convention, default value of the number of users is one.

No constraint for file names as long as it has a ".xml" extension.

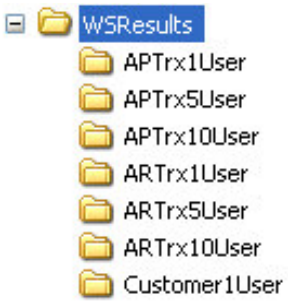


Figure 1. Sample Folder Structure of XML Test Results

The following example is a XML result file.

```
<?xml version="1.0" encoding="utf-8" ?>
        <root>
            <tests>
              <test>
                <name>PayablesInvoice</name>
                <starttime>6/29/2006 9:03:02 AM</starttime>
                <type>performance</type>
                <machine>H16649</machine>
                <os>Win32NT</os>
                <osVersion>5.1.2600.131072</osVersion>
                <netFramework>2.0.50727.42</netFramework>
                <event>
                        <time>9:03:07 AM</time>
                        <type>Iteration</type>
```

```
                <message>Iterations</message>
                <iteration>10</iteration>
                <data>208</data>
            </event>
            ...

            <event>
            ...
            </event>
        </test>
    </tests>
</root>
```

The <test> element contains information of a test suite. The test tags include:

- <name>: test name
- <starttime>: time at which the results were logged
- <type>: the type of test
- <machine>: machine name on which the test was run
- <os>: operating system
- <osVersion>: version of the operating system
- <netFramework>: version of the .NET framework
- <event>: information of this particular iteration

The tags inside the <event> tag include:

- <time>: time at which this iteration of the test case was recorded
- <type>: type of entry
- <message>: description message
- <iteration>: iteration index
- <data>: total response time for this iteration

2.3.2 TXT Test Results

The test results should be stored in a one-level folder structure. The folder is the physical location for all the TXT files of this test run. No subfolder is allowed. File name should end with the number of users to indicate the user load. For example, the file name "glent7.txt" means the scenario or module name is "glent", and seven users are simulated.

The raw data are saved in delimited plain text file. Each line in the files contain the following data:

- TestID: Test ID assigned to a test run
- UserID: User ID index
- EventID: a unique ID used to identify a test case
- Time: time at which the results are logged
- MSTime: number of milliseconds since benchmarks started
- Type: flag to show start or stop: 0 = start, 1 = stop
- RowID: row index

The following is an example of the contents from a result text file.

TestID	UserID	EventID	Time	MSTime	Type	RowID
100	2	1101	1/1/1900 5:56:15 PM	18760	0	1
100	1	1101	1/1/1900 5:56:15 PM	18766	0	2
100	4	1101	1/1/1900 5:56:15 PM	18769	0	3
100	7	1101	1/1/1900 5:56:15 PM	18775	0	4
100	5	1101	1/1/1900 5:56:15 PM	18781	0	5
100	3	1101	1/1/1900 5:56:15 PM	18788	0	6
100	6	1101	1/1/1900 5:56:15 PM	18790	0	7
100	7	1101	1/1/1900 5:56:21 PM	24083	1	8
100	1	1101	1/1/1900 5:56:21 PM	24084	1	9
100	3	1101	1/1/1900 5:56:21 PM	24088	1	10
100	5	1101	1/1/1900 5:56:21 PM	24105	1	11

CHAPTER III

HIGH-LEVEL AND LOW-LEVEL DESIGN

Based on the specification analysis, several design models of the system are developed at difference levels of abstraction. This chapter describes the high-level and low-level design in details.

3.1 System Architecture

System architecture is the top-level design that gives us the overview of the whole project. There are three main architectural pieces as shown in Figure 2:

1. Data consolidation and importing tool, which can be further divided into several functional components.
2. Raw data files generated by performance test.

   These files are the input files for the import tool and must be stored in a consistent format.
3. SQL database to store the processed data.

   The production database is hosted on a remote SQL Server named RM_PERFORMANCE. For development and testing purpose, the project uses ABench database on local machine.

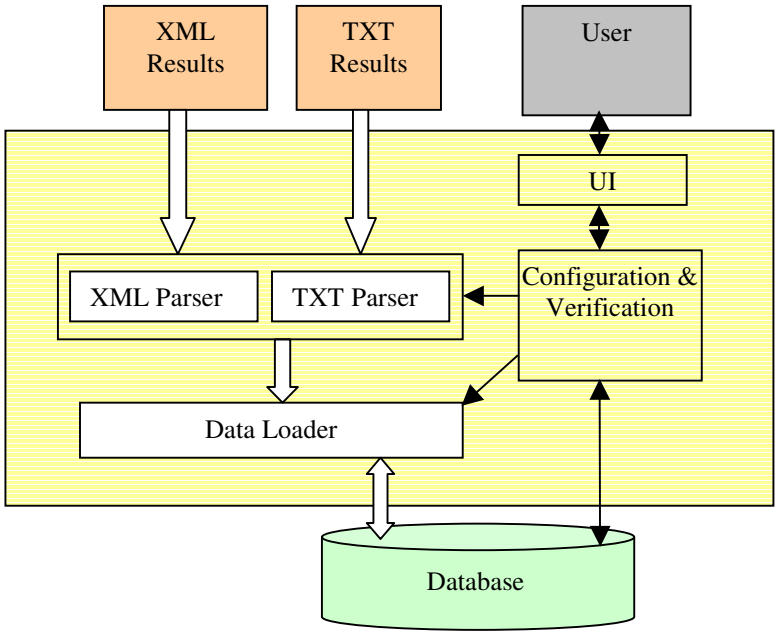


Figure 2. System Architecture

The data consolidation and importing tool itself can be broken down to user interface and three major functional components:

1. User interface: It allows users to enter necessary information to setup and run the tool.
2. Configuration & verification unit: This unit performs the following tasks:
   - Receives inputs from the user interface.
   - Checks configuration files availability, Database connectivity, default application setting, etc.
   - Checks if the predefined data has been setup correctly in Database tables, such as test cases, performance counters, etc.
   - If existing build number has been selected from the user interface, prompts user to choose whether to overwrite or append to previous test run.

- Launches the data parser

3. Data Parser: based on the file type of the test results, one of the Parser classes is instantiated: XMP Parser or TXT Parser. Its functionalities include
    - Get the input files
    - Parse through files and process data, conduct calculation when necessary
    - Organize and save data in a consistent format
    - Pass processed data to data loader
4. Data Loader
    - Get processed data from Parser
    - Verify data integrity according to database model and configuration file
    - Upload the valid results to database

3.2 Use Case Diagram

Use case diagram is used to show the interaction between actors and the system. An actor represents a user or another system that will interact with the system. A use case is an external view of the system that represents some action the user might perform in order to complete a task [1]. In this project the only actor is the user.

The use cases are:

1. Input application settings, which include
    - Input application type
    - Input operating system
    - Input execution tier (hardware and server information)
2. Input build number for this application
3. Specify input files. This task include two steps:

- Input result folder
- Select test files to process

4. Start process. User starts the process via User Interface.

Figure 3 demonstrates the User Case Diagram for this project.

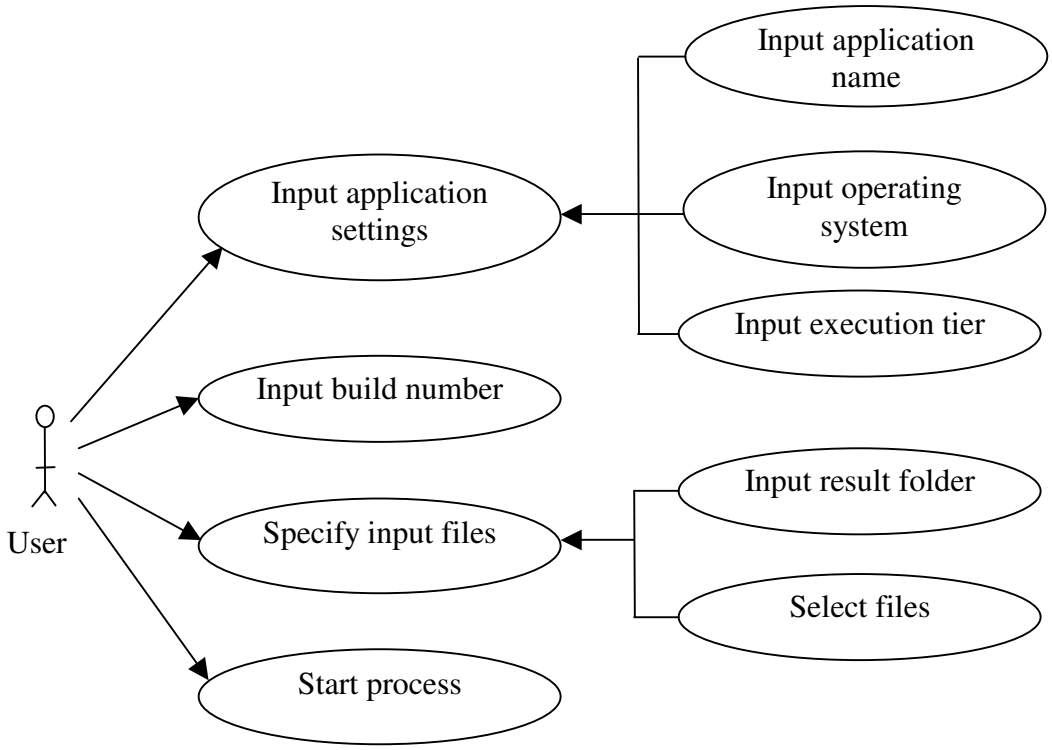


Figure 3. Use Case Diagram

3.3 Data Flow Diagrams

A Data Flow Diagram (DFD) shows the flow of data from external entities into the system and how the data moves from one process to another. DFD may partition into levels that represent increasing information flow and function detail. For this project, three-level DFDs are developed. Figure 4 to Figure 8 show DFDs using the Gane and Sarson notation [1], which include four symbols:

- Squares representing external entities.
- Bubbles representing processes, which take data as input and output.
- Arrows representing the data flows.
- Open-ended rectangles representing data stores, such as databases or XML files.

3.3.1. Level-1 Data Flow Diagram

Level-1 data flow diagram is also called context model or a fundamental system model. The whole system is considered as a process.

As shown in Figure 4, the system takes four kinds of input data:

- User input: User provides application settings, build number, and test file information.
- Helper database: A helper database is needed for the system to store additional data such as lookup table and performance counter information. The system needs to access these data to successfully parse the test files.
- Configuration file: This file contains default settings for this system as well as configurations for each application type.
- Test files: Test results to be processed.

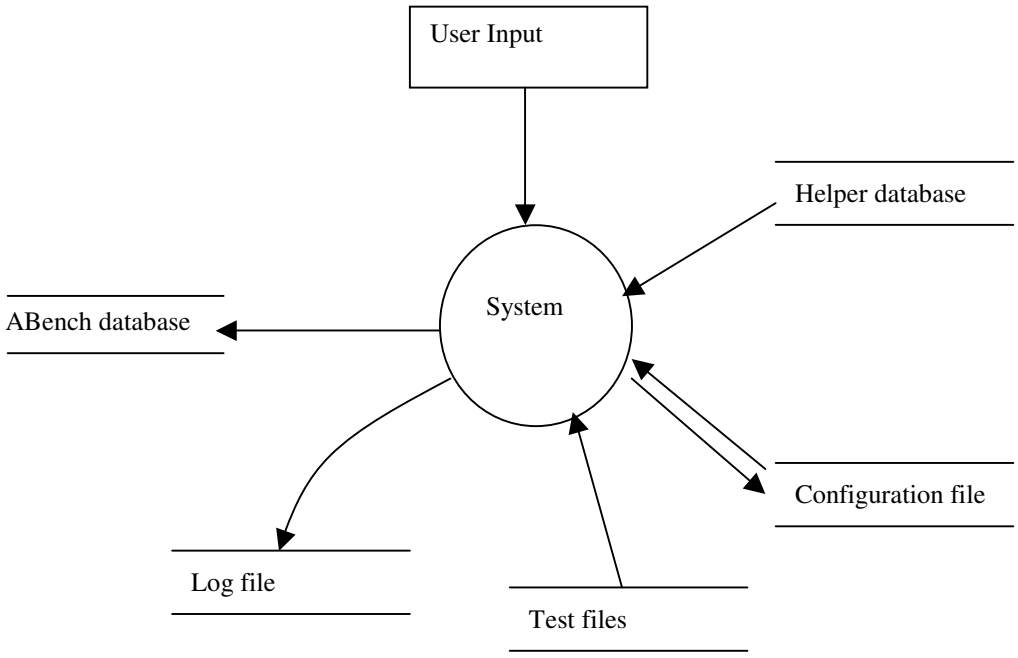


Figure 4. Level-1 Data Flow Diagram

And there are three kinds of output data:

- Configuration file: The system can save current application settings as default into the configuration file.
- ABench database: Processed data are uploaded to ABench database.
- Log file: The system save the running record of this process to a log file, such as the number of files parsed, the number of data rows uploaded, etc.

3.3.2. Level-2 Data Flow Diagram

Since there is only one process shown in level-1 DFD, it is unclear for the algorithm applied to transform the input to the output. We can partition the level-1 DFD to level-2 DFD to reveal more detail, as shown in Figure 5.

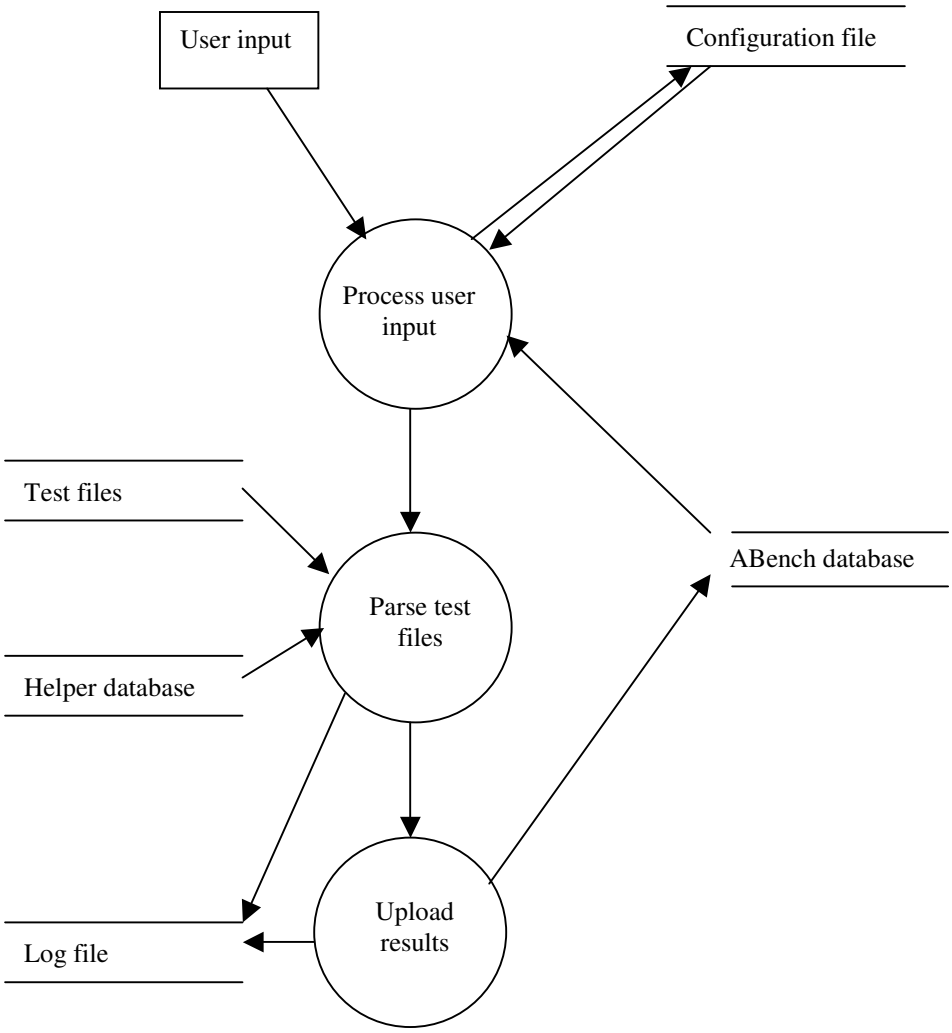


Figure 5. Level-2 Data Flow Diagram

There are three processes in this Data Flow Diagram.

- Process User Input, which include
  - Retrieve data from ABench database tables about available application types, operating systems, execution tiers and build numbers.
  - Extract default application settings from the configuration file.
  - Display above information on the User Interface and takes user input.
  - Process and pass information to the next process.

- Parse test files, which include
    - Get information from the previous process
    - Get information from help database and parse the test files
    - Pass the processed data to the next process
    - Record running information to log file
- Upload results, which include
    - Get processed data from the previous process
    - Upload data to ABench database
    - Record running information to log file

Please note that level-2 DFD does not show the details about the data flows and transforms between the processes.

3.3.3. Level-3 Data Flow Diagram

Level-2 DFD can be further partitioned to level-3 DFDs for each process. In these level-3 DFDs, internal data objects used to transfer information between processes are explained.

- Process user input

This process is further broken down to four services functions, as shown in Figure 6. There are two kinds of output data for this process: file information data object and user input data object. These two data objects will be transferred to the next process.

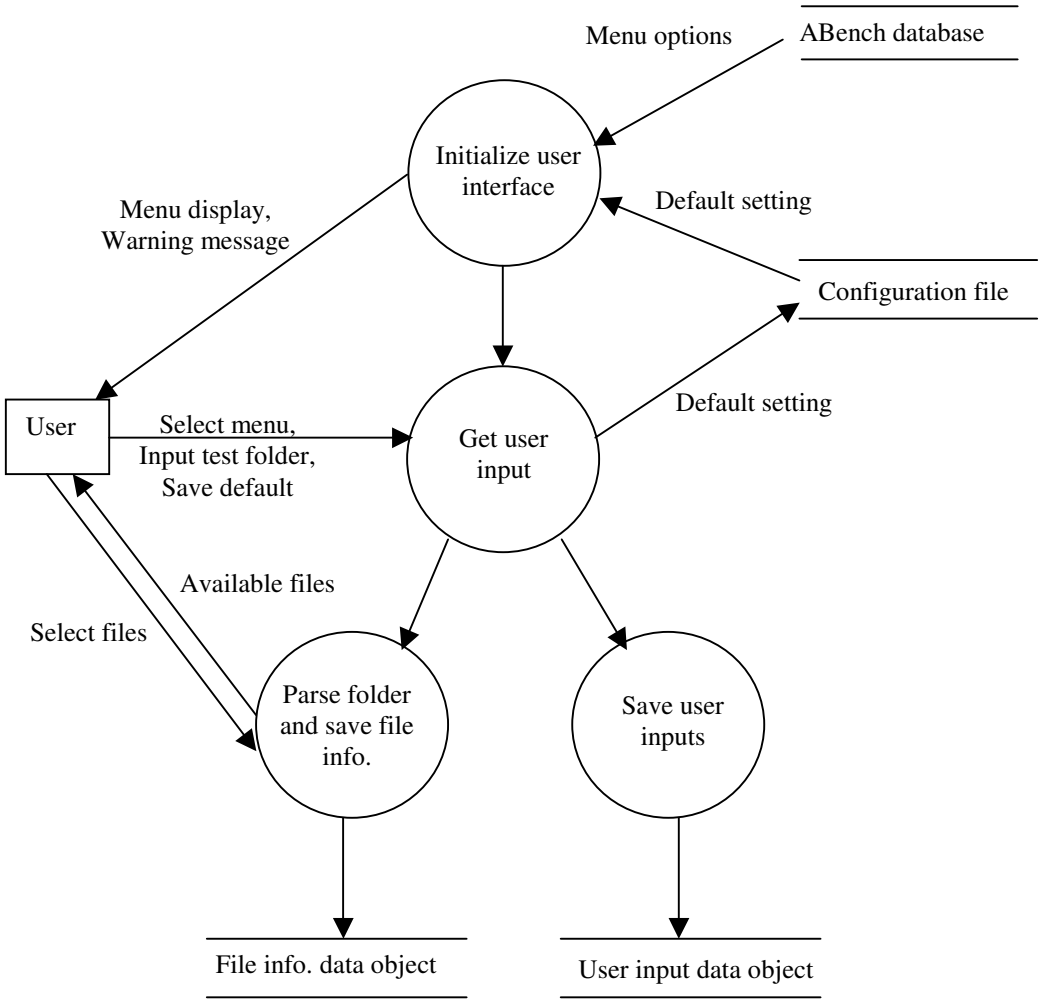


Figure 6. Level-3 Data Flow Diagram: Process user input

The four service functions are:

- Initialize user interface. This function displays user interface to end-user. It queries the ABench database tables to create menu options. It extracts data from the configuration file for default application settings, which are used to set selected menu items. It also gives warning messages if it fails to connect to the database or cannot find the configuration file.

- Get user input. This function gets the user input when the user selects items from menu, inputs test folder or chooses to save the settings as default. It also save the default settings to the configuration file if user decides to so.
- Parse folder and save file information. This function will parse through the folder and display available files to user interface. It takes input when the user selects from the displayed files. It also extracts the information of "number of users" from the folder/file names. Finally it saves all the file information into an easy-access data object.
- Save user inputs. This function saves user inputs into an easy-access data object.

- Parse test files

Level-3 DFD for this process is shown in Figure 7. As one can see in the diagram, this process takes two data objects generated by the previous process. At the end of the process, it saves the results to a new test case results data object as an output.

Here are the service functions:

- Create parser. This function takes the parser type information from the user input data object and creates a parser object accordingly.
- Create lookup table. This function gets application type from the user input data object. It then creates a lookup table in memory by querying the helper database.
- Parse files. This function takes input from file information data objects, and then uses the lookup table to find test case information including test case IDs and names. It parses through every test file, does necessary calculations on the

raw data, and summarizes all the results of this test run into a new test case results data object. It displays message to user if needed and record running information to log file.

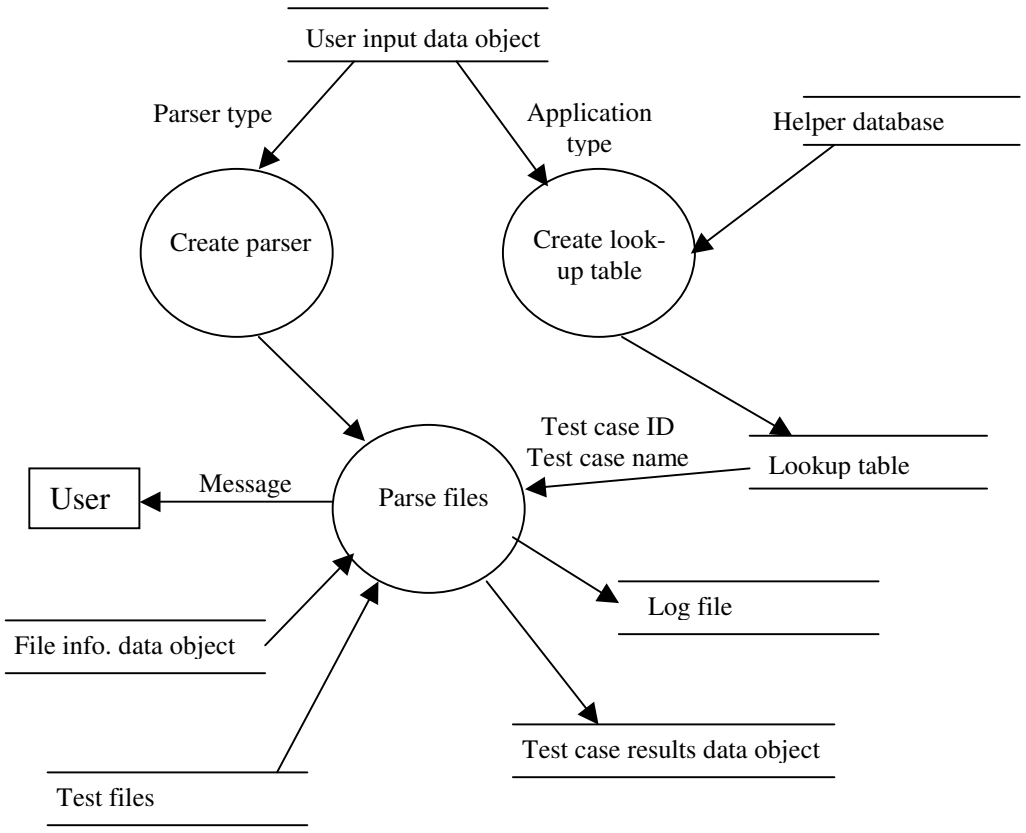


Figure 7. Level-3 Data Flow Diagram: Parse test files

- Upload results

Figure 8 represents level 3 DFD for this process, which can be divided into two service functions. This process takes the test case results data object from the previous process. It validates the data and uploads valid data to ABench database tables. The final outputs are inserted rows in the database. Running information is recorded in log file and messages are displayed for the user.

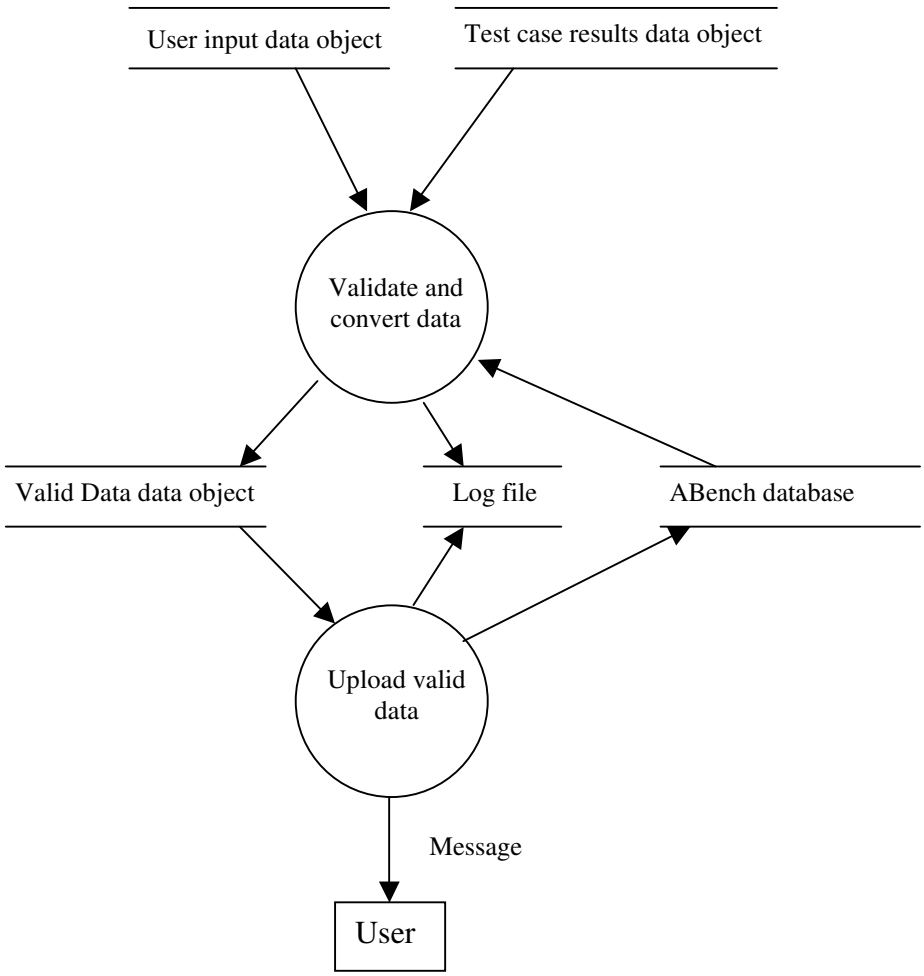


Figure 8. Level-3 Data Flow Diagram: Upload results

- Validate and convert data. This function gets inputs from user input data object and test case results data object. It loops through the test case results to validate data by querying the ABench database tables. It calls a private method to convert valid data into a data object ready for database uploading.
- Upload data. This function uploads the valid-data data object to ABench database tables. Depending on the user's need, it may overwrite or append the records in the tables for the current build number. Information is logged to file and displayed to user.

3.3.4. Conclusion of Data Flow Diagrams

These three levels of data flow diagrams give clear insights of system design in a top-down approach. Detailed design and implementation for each functional component can start from the level-3 DFDs.

Please be noted that there might be a variety of smaller functional units to support each service function, such as methods of database access, searching and sorting, etc. These functional units are the smallest building blocks of the system, however, they are too detailed to be included in data flow diagrams.

3.4 User Interface Design

User interface design aims to create an effective communication medium between the user and the system. The design begins with identification of users, tasks and environmental requirements. After the functionality analysis and modeling, user scenarios are created to define a set of interface objects and actions. Based on the interface objects and actions, layouts of the interface elements are generated, such as menus, icons, buttons, etc.

This system uses a windows-based graphical user interface, as shown in Figure 9. The interface was designed using Microsoft Visual Studio 2005, which provides rich user interface features for Microsoft Windows operating system.

The user interface is easy to use and setup. The main part of interface is a Windows Form that prompts the user for additional information for menu items. It has the following components (Windows controls) and functionalities:

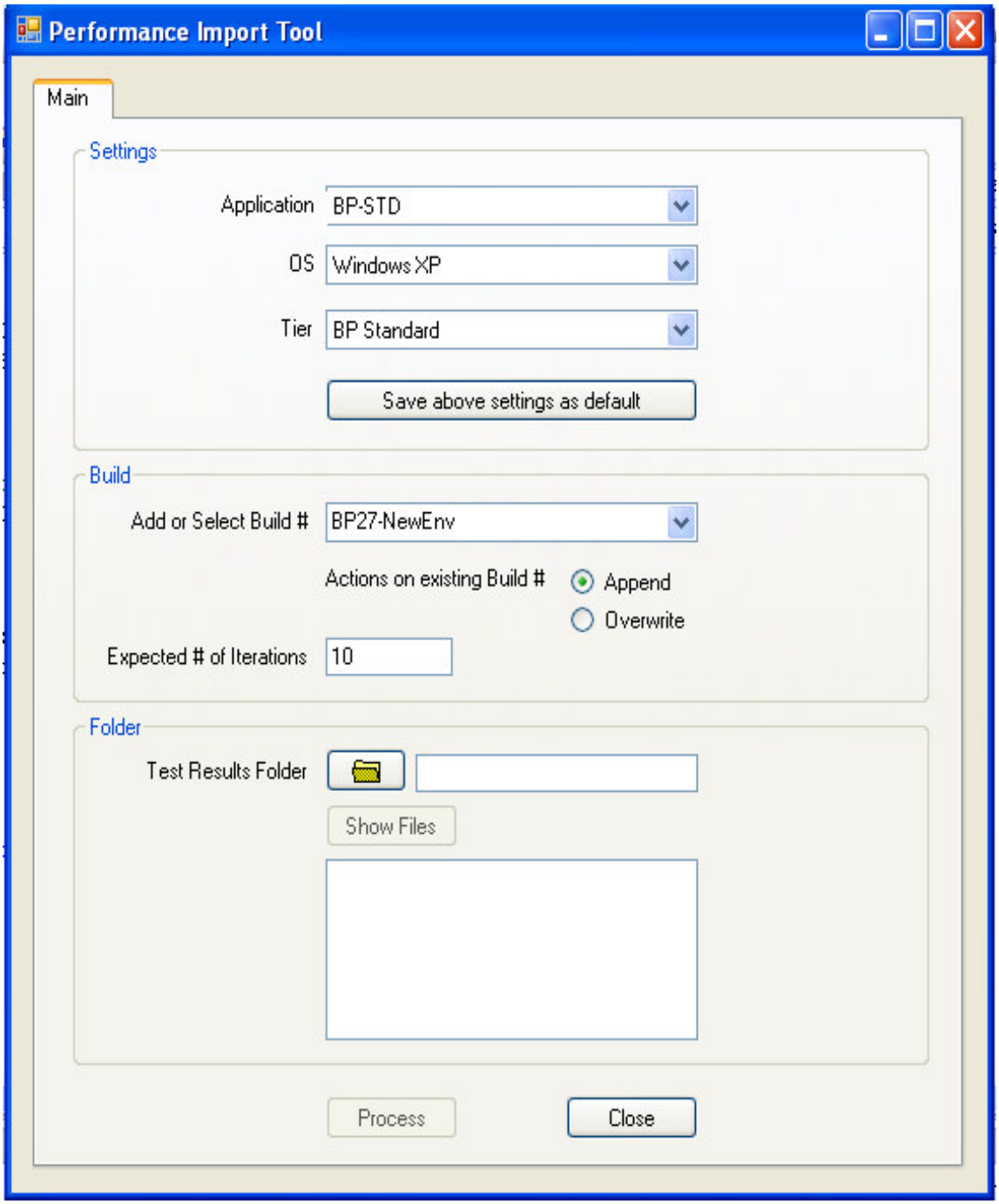


Figure 9. User Interface: Main Entry

1. "Application" ComboBox

    - The control is for Select only.

- Items are retrieved from database.
- User must select an existing Application Type from the list.

2. “OS” ComboBox
   - The control is for Select only.
   - Items are retrieved from database.
   - User must select an existing Operating System from the list.
3. “Tier” ComboBox
   - The control is for Select only.
   - Items are retrieved from database.
   - User must select an existing Execution Tier from the list.
4. “Save above settings as default” Button
   - Set the selected Application type, OS and Tier as the default values. These data will be saved in the configuration file.
5. “Add or Select Build #” ComboBox
   - User must either write in the box to add a new Build Number or select an existing one from the dropdown list.
   - Dropdown list items are retrieved from database.
   - Input data validation enabled.
6. “Actions on existing Build #” RadioButtion
   - This control depends on user’s action on control 5
     i. Disabled if user added a new Build Number, as shown in Figure 10
     ii. Enabled if user selected an existing Build Number.

- It has two options for the existing Build Number
    i. Append new results to the previous test run (default value)
    ii. Overwrite the results of previous test run

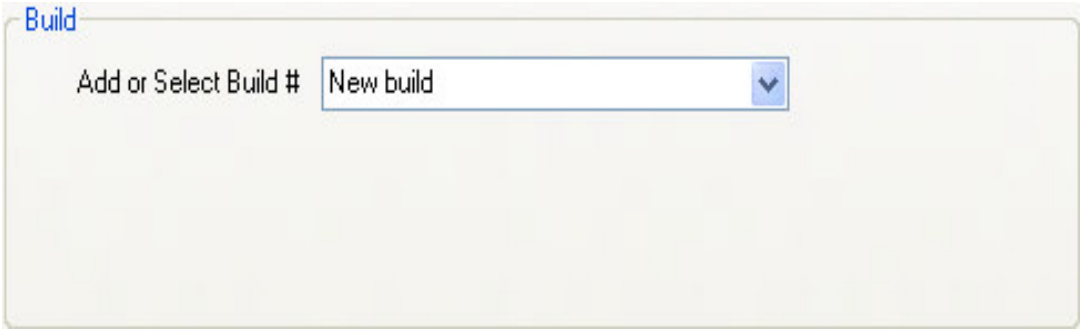


Figure 10. User Interface: Radio Button Disabled

7. "Expected # of Iterations" TextBox
    - This control depends on data from configuration file
        i. Disabled if <showExpectedIteration> value for this application type is False
        ii. Enabled if <showExpectedIteration> value for this application type is True
    - User needs to input an integer value in the box. The value is used to check if iterations processed for a test case matches the expectation.
    - Input data validation enabled.

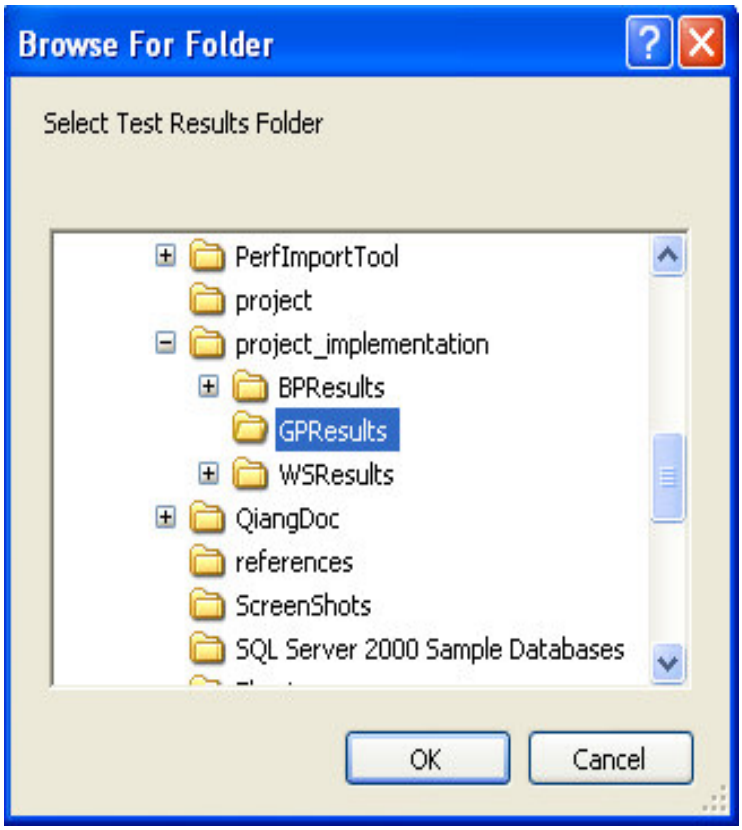


Figure 11. User Interface: Folder Browser Dialog

8. "Test Results Folder" Button
    - User clicks this button to open a Folder Browser Dialog, as shown in Figure 11. The dialog is used to select the test results folder by navigating to the location and then clicking OK.
    - The selected full path from Folder Browser Dialog will be shown in the TextBox (control 9) next to this button.
9. "Test Results Folder" TextBox
    - User has two options to populate this box with the full path of test results folder

i. Click on the button in front of this box and select from the folder browser dialog, as described previously.

ii. Write the full path in the box.

- Input data validation enabled.

10. “Show Files”/”Select Files” Button

- This control depends on the contents of control 9

  i. Enabled if “Test Results Folder” TextBox is not empty

  ii. Disabled otherwise

- The name depends on data from configuration file

  i. If <alwaysParseAllFiles> value for this application type is true, name is “Show Files”

  ii. If <alwaysParseAllFiles> value for this application type is false, name is “Select Files”

- Click it will parse the folder specified in “Test Results Folder” TextBox (control 9) and populate the below Files ListBox (control 11) with all eligible files found in the folder.

11. Files ListBox

- Disabled by default; Enabled after clicking “Show Files”/”Select Files” Button (control 10).
- Lists all eligible files found in the test results folder.
- User needs to selects files to process

i. If control 10 is “Select Files”, user can select individual files to process (see Figure 12). If user does NOT select any file in the list, ALL files will be processed by default.

ii. If control 10 is “Show Files”, user cannot select individual files to process. ALL files will be processed always.

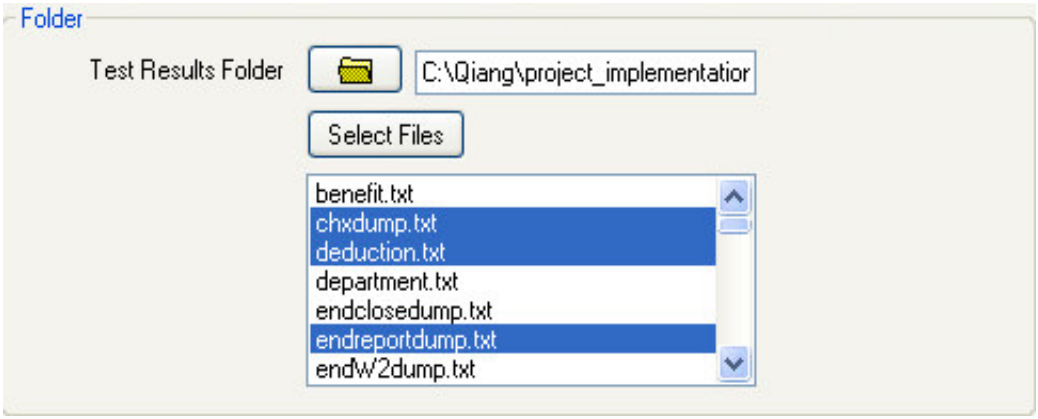


Figure 12. User Interface: Select Files in List

12. File viewer

- Opens up when user double-clicks a file name in the listbox (control 11).
- Displays contents of the file in a spreadsheet format for user’s convenience. Figure 13 shows an example. The file used in the example is “glent.txt”.

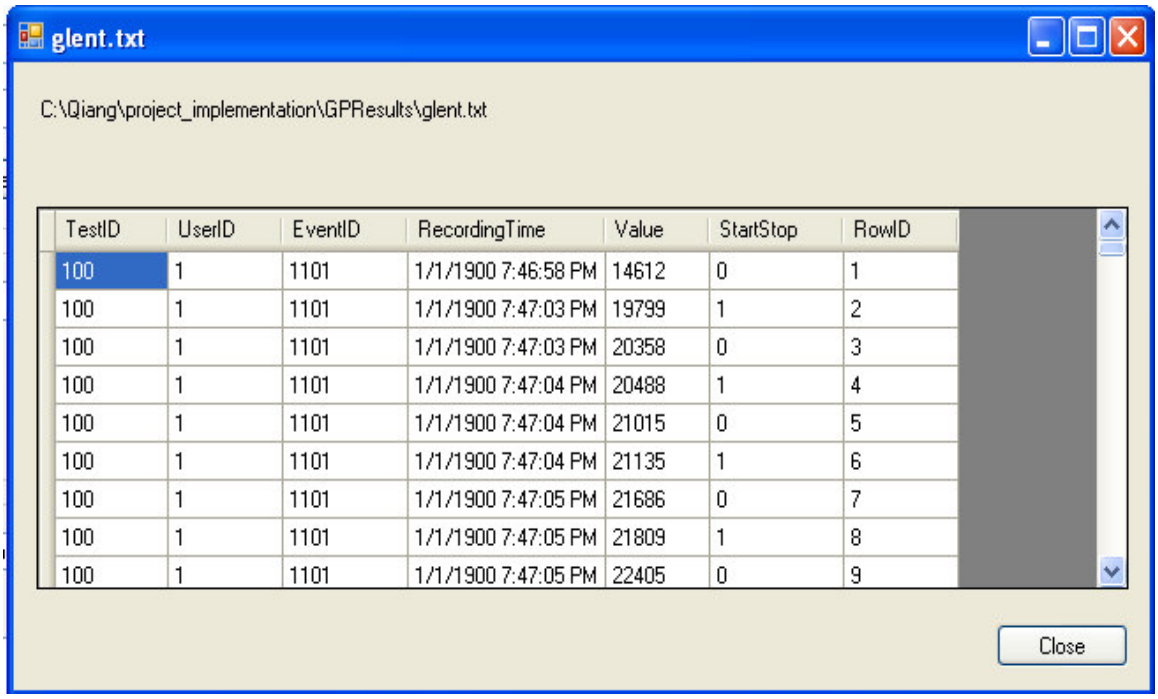


Figure 13. User Interface: File Viewer Example

13. “Process” Button

- Disabled by default; Enabled after Files ListBox (control 11) has been populated, which means there are files to process.
- Clicks to start the process, which include
    i. Validates input data
    ii. Launches backend process driver

14. “Close” Button

- Close the main Windows Form and terminates the system.

In addition to the controls in main form discussed above, a few Message boxes are used to display warnings, errors, progress status, etc. when necessary. For example, Figure 14 shows an error message for invalid input value of Expected iteration.

Figure 14. User Interface: Message Box Example

CHAPTER IV

IMPLEMENTATION

After completing the high level and low level design, the functional modules are implemented by using C# and .NET framework. The development environment is Visual Studio (VS) 2005 and SQL Server 2005 is used for backend database solution. Transact-SQL statements are used for database queries and scripts. The complete source code is in the attached CD. This chapter discusses implementation details by giving class diagrams and data models and accesses.

4.1 Class Diagrams

Class diagrams are used to describe a group of classes in a system and their relationships, such as containment, inheritance and associations [2]. A class represents an entity of a given system that provides an encapsulated implementation of certain functionality [3]. In C#, classes are composed of three things: a name, attributes that include fields and properties, and some methods to fulfill the functionalities.

This system consists of thirty classes. Among them, four classes are generated automatically by the VS development environment to start a Windows Form application. The remaining classes are explained in detail in class diagrams.

4.1.1 Package-Level Class Diagram

Classes that are either similar in nature or related are grouped in a package. This provides better readability for complex class diagrams. There are four class packages in this system, as shown in Figure 15 to Figure 18.

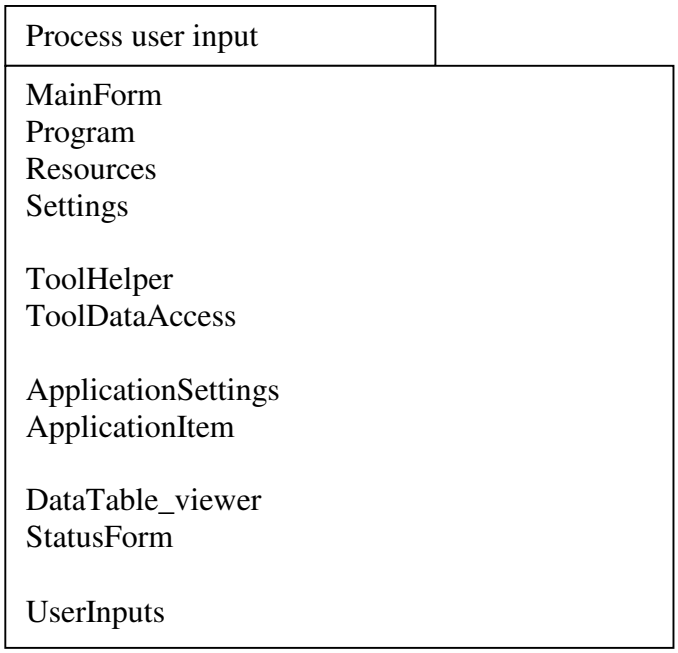


Figure 15. Package-Level Class Diagram: Process User Input

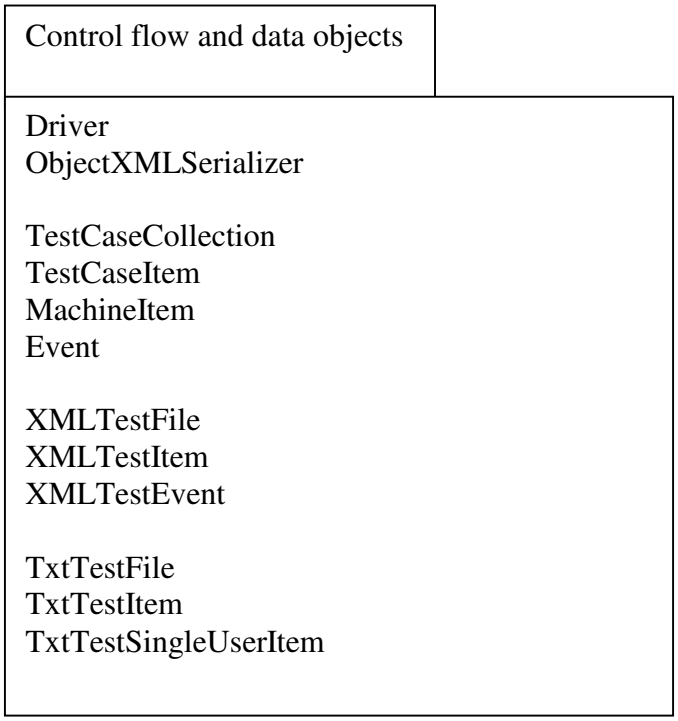


Figure 16. Package-Level Class Diagram: Control Flow and Data Objects

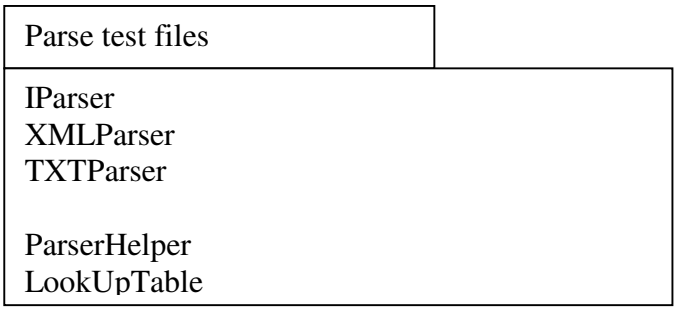


Figure 17. Package-Level Class Diagram: Parse Test Files

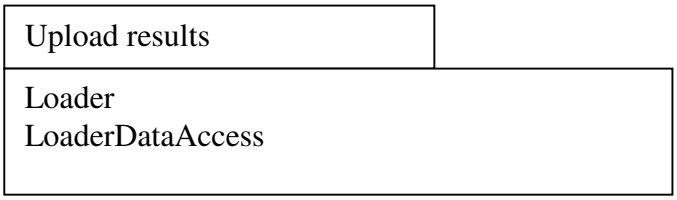


Figure 18. Package-Level Class Diagram: Upload Results

4.1.2 Class-Level Class Diagram

Figures 19 to 31 demonstrate class level class diagrams. The class functionalities and relationships are displayed in details. Classes that are generated by the Visual Studio 2005 automatically are not described here, which include MainForm, Program, Resources, and Settings.

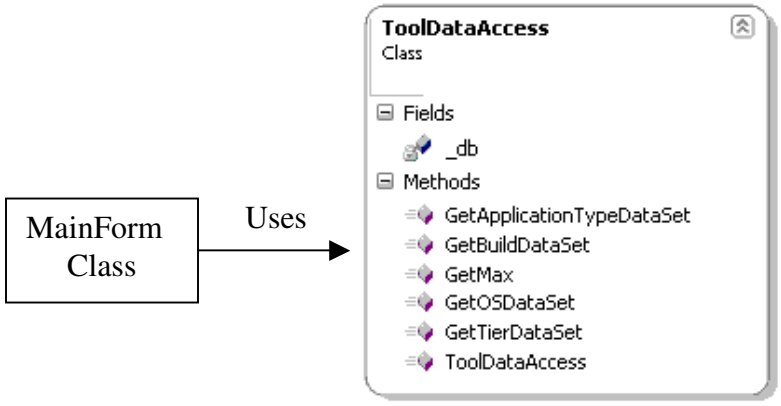


Figure 19. Class-Level Class Diagram: ToolDataAccess

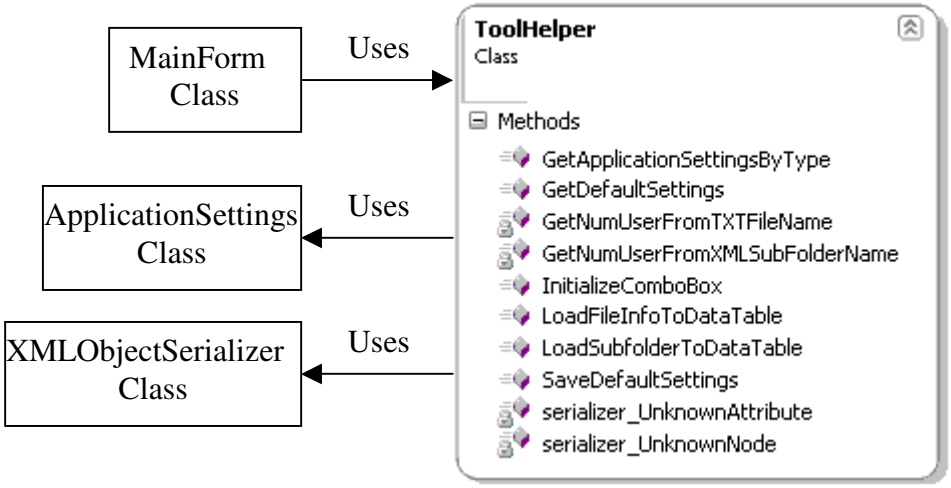


Figure 20. Class-Level Class Diagram: ToolHelper

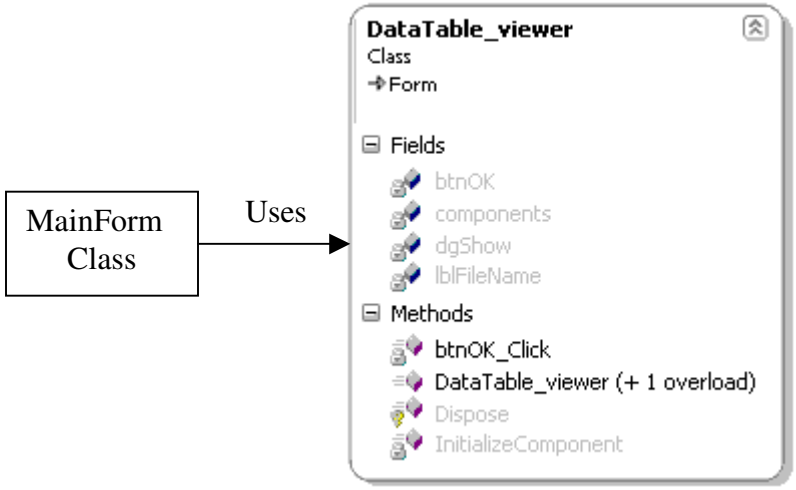


Figure 19. Class-Level Class Diagram: DataTable_viewer

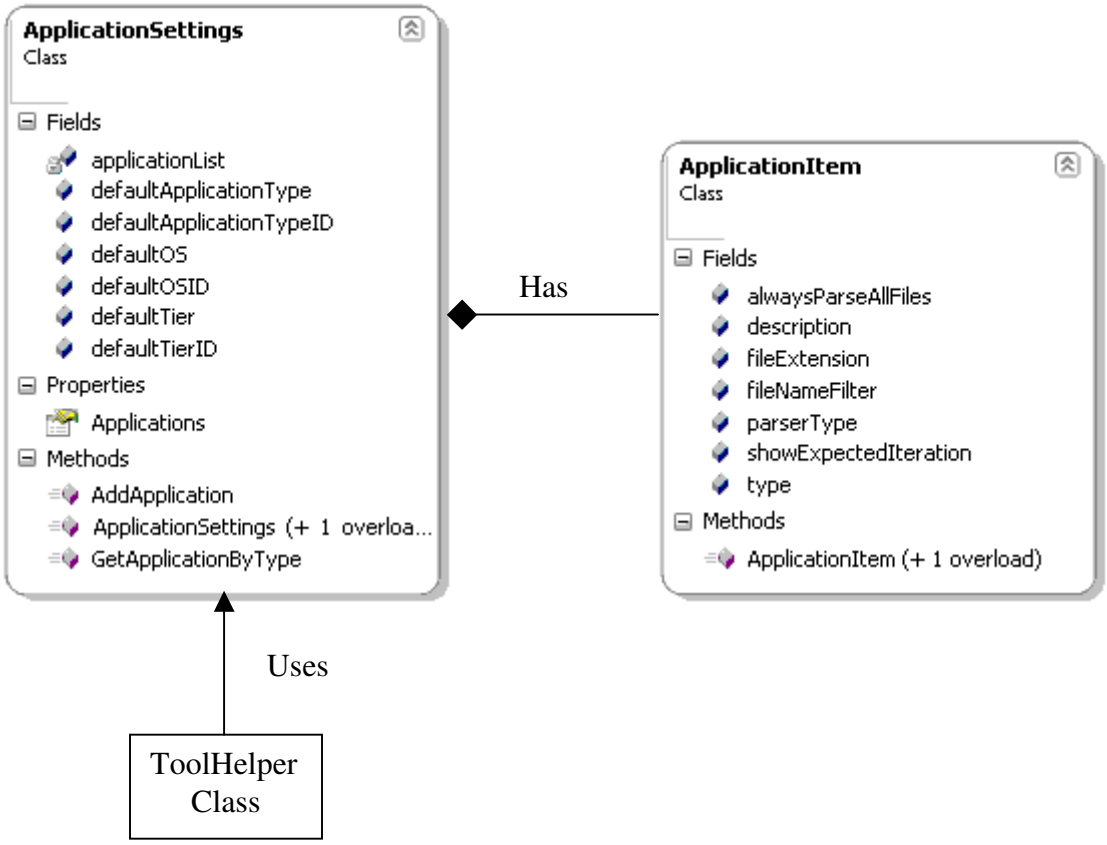


Figure 20. Class-Level Class Diagram: ApplicationSettings and ApplicationItem

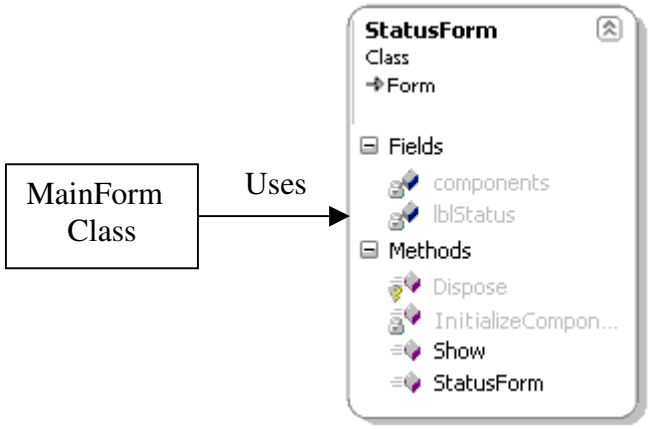


Figure 21. Class-Level Class Diagram: StatusForm

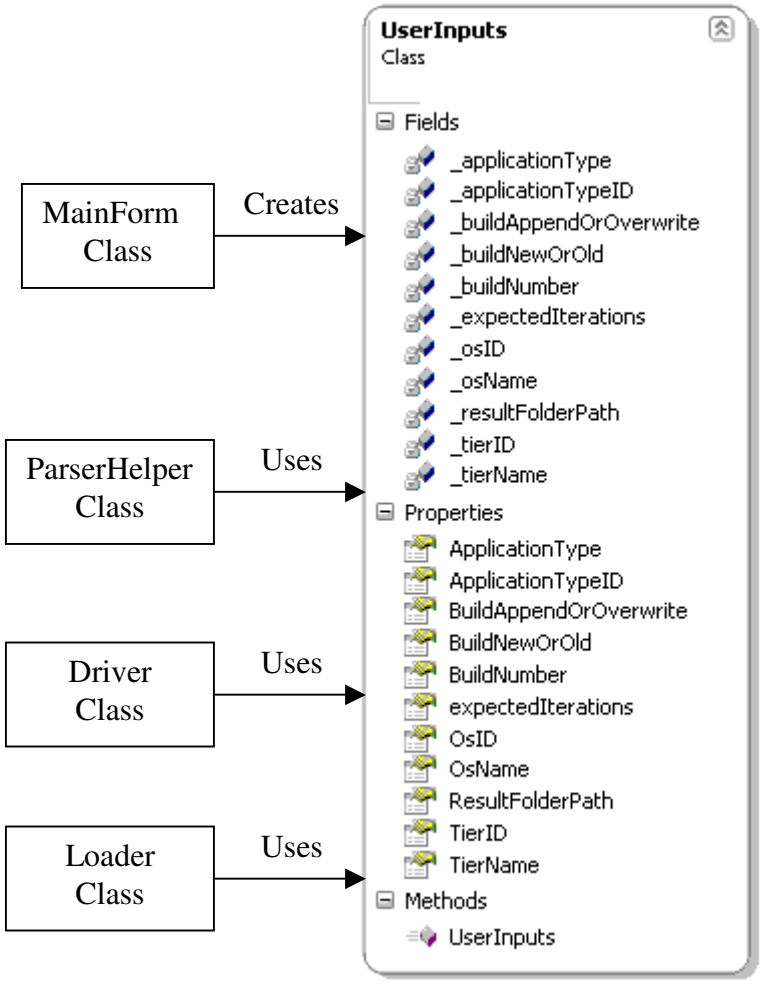


Figure 22. Class-Level Class Diagram: UserInputs

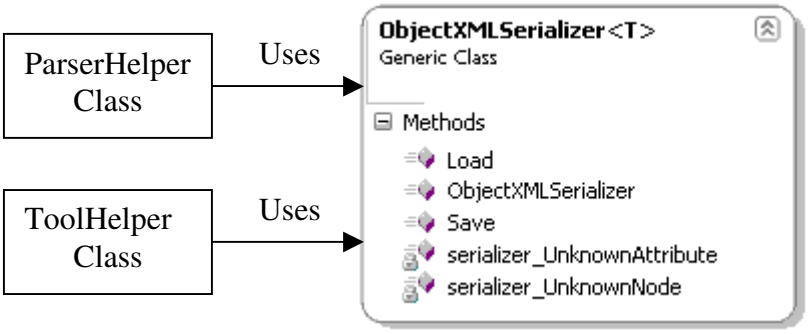


Figure 23. Class-Level Class Diagram: ObjectXMLSeriaLizer

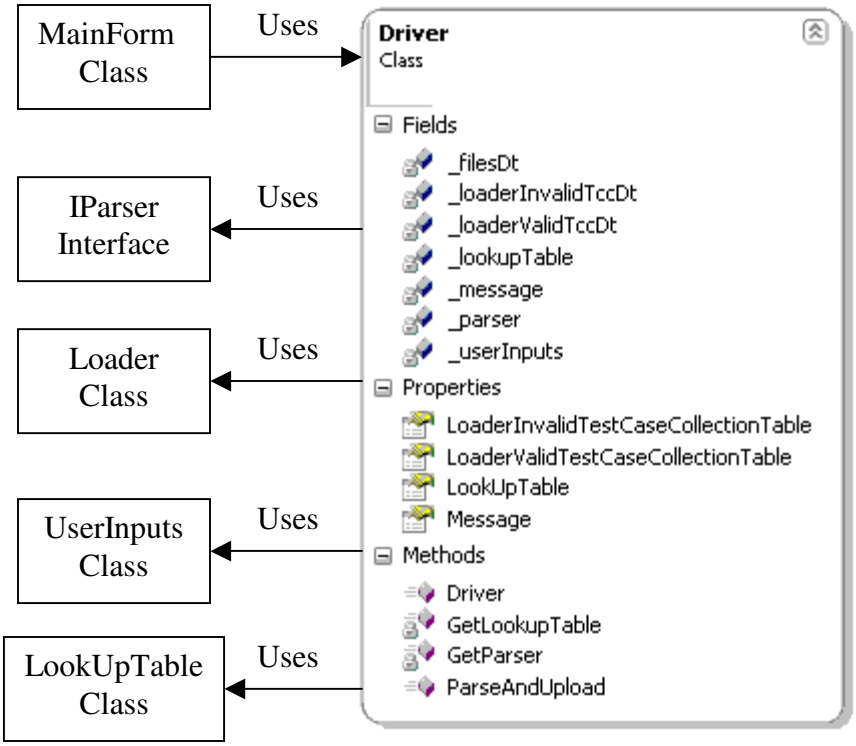


Figure 24. Class-Level Class Diagram: Driver

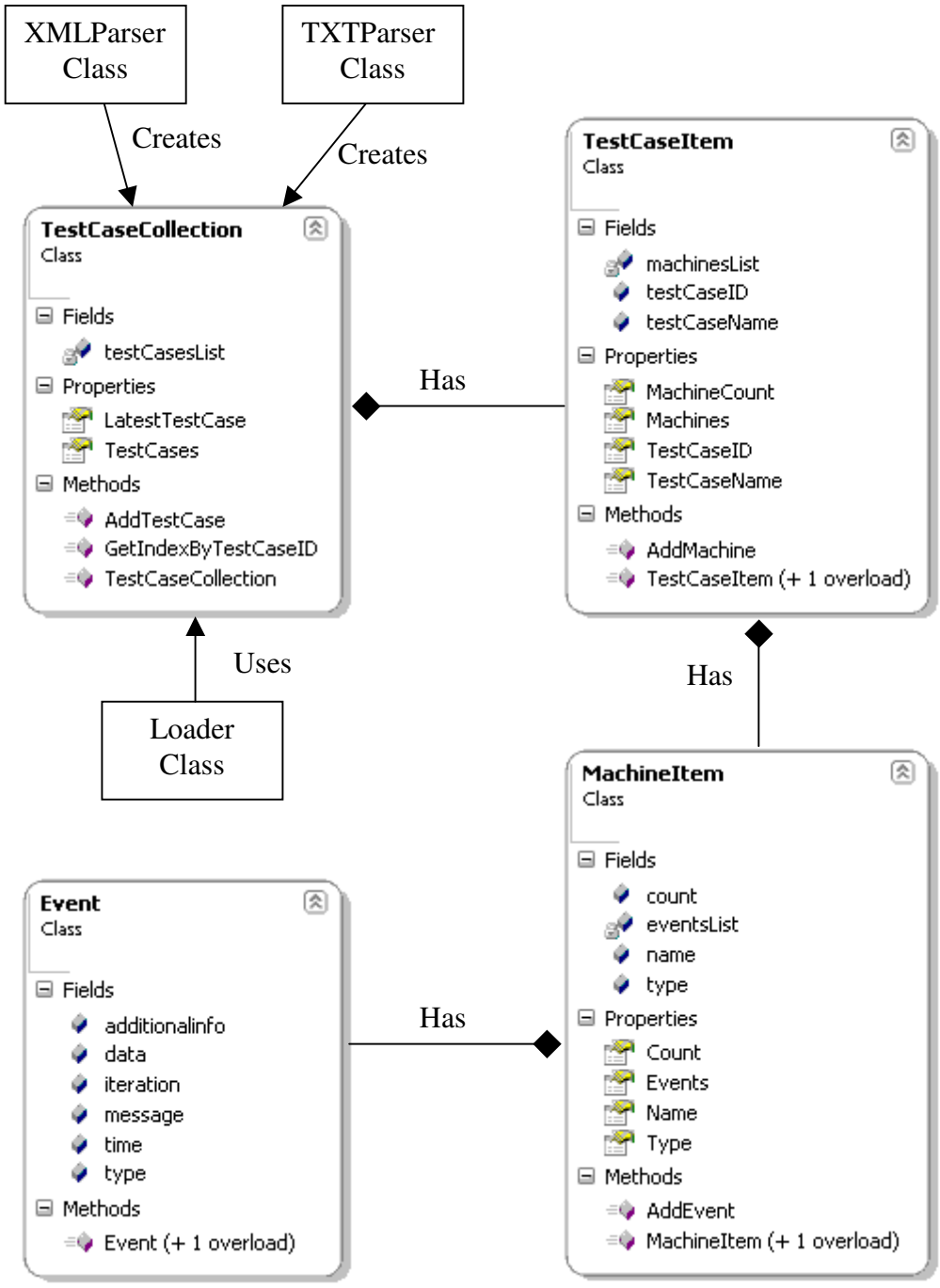


Figure 25. Class-Level Class Diagram: TestCaseCollection, TestCaseItem, MachineItem and Event

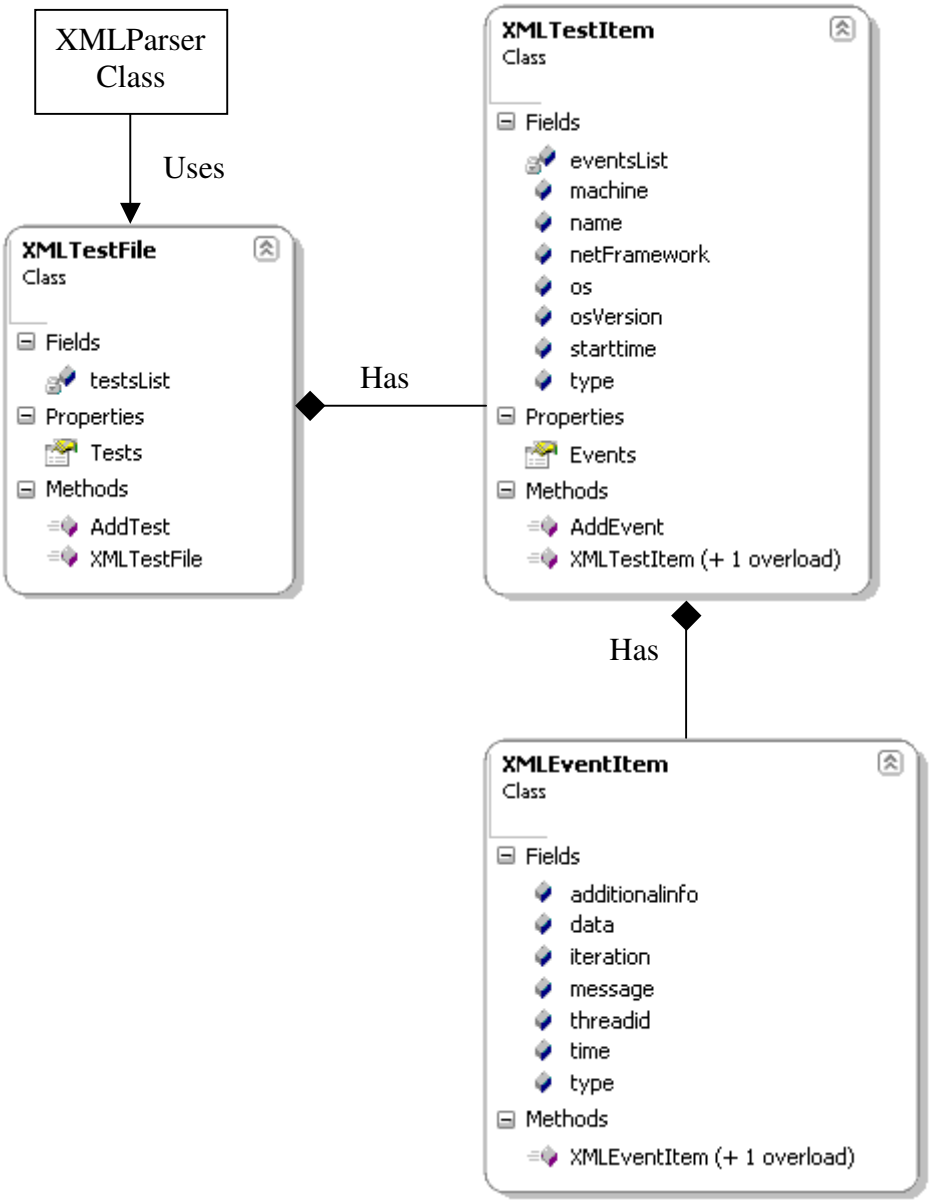


Figure 26. Class-Level Class Diagram: XMLTestFile, XMLTestItem and XMLEventItem

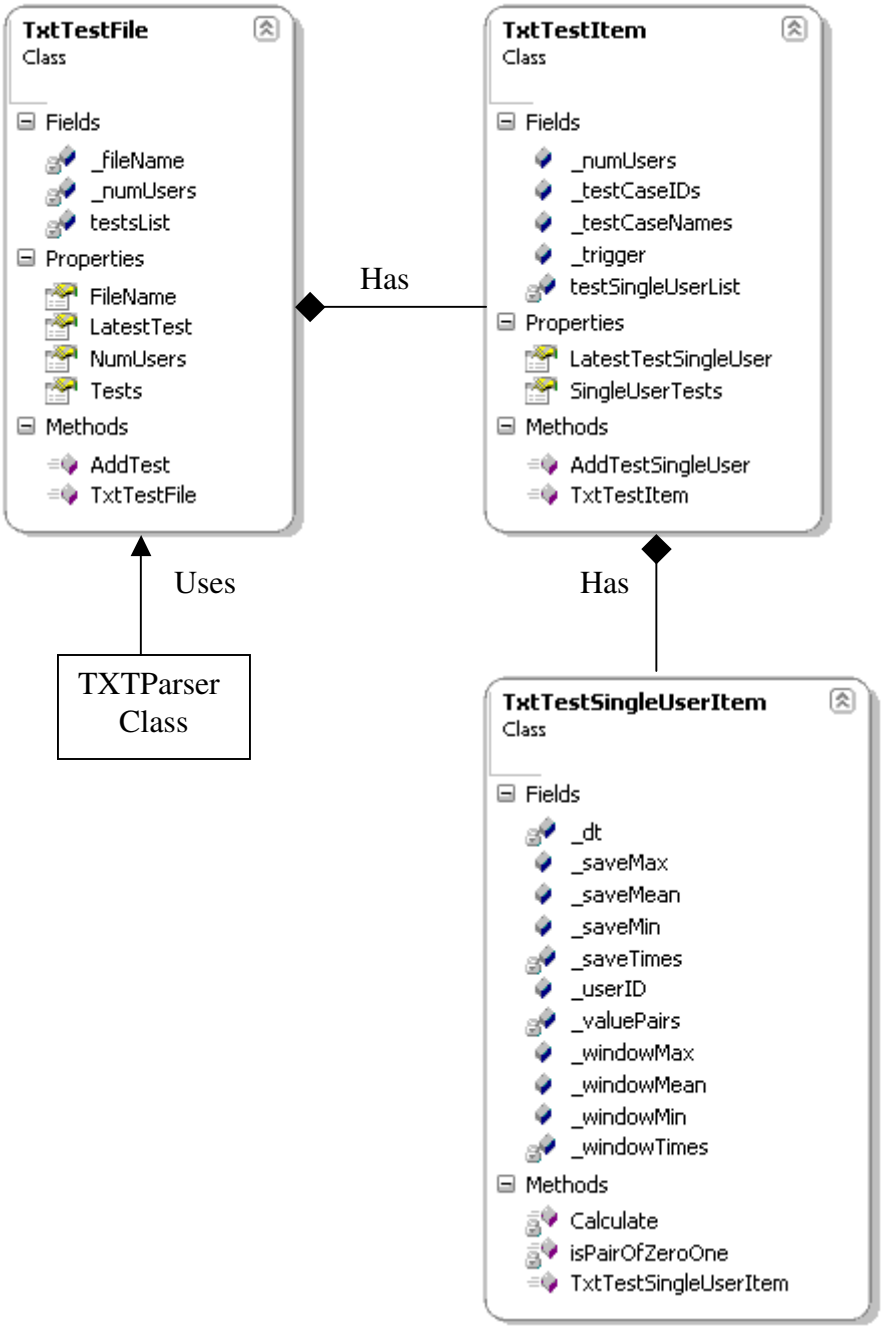


Figure 27. Class-Level Class Diagram: TxtTestFile, TxtTestItem and XMLSingleUserItem

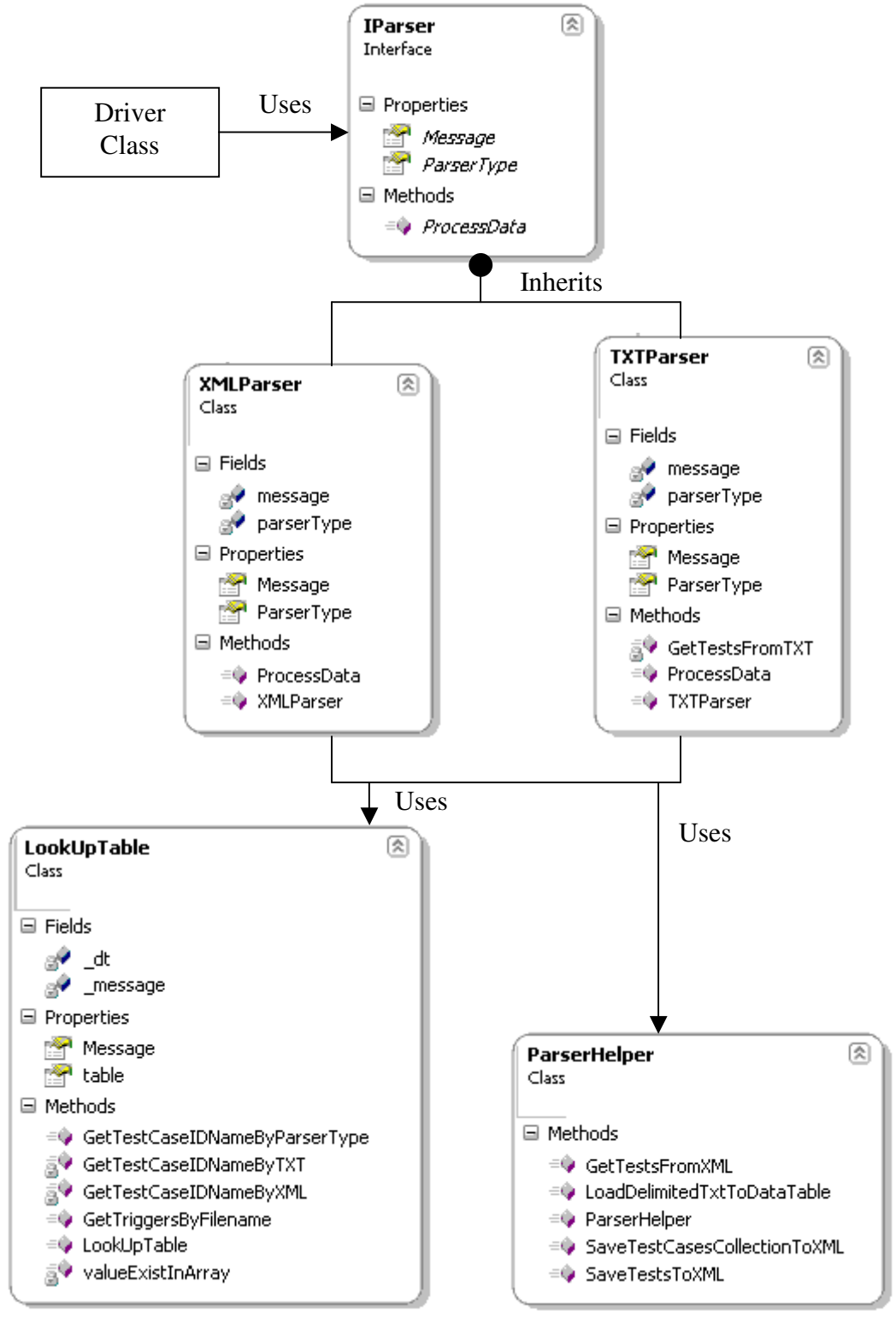


Figure 28. Class-Level Class Diagram: IParser, XMLParser, TXTParser, LookUpTable and ParserHelper

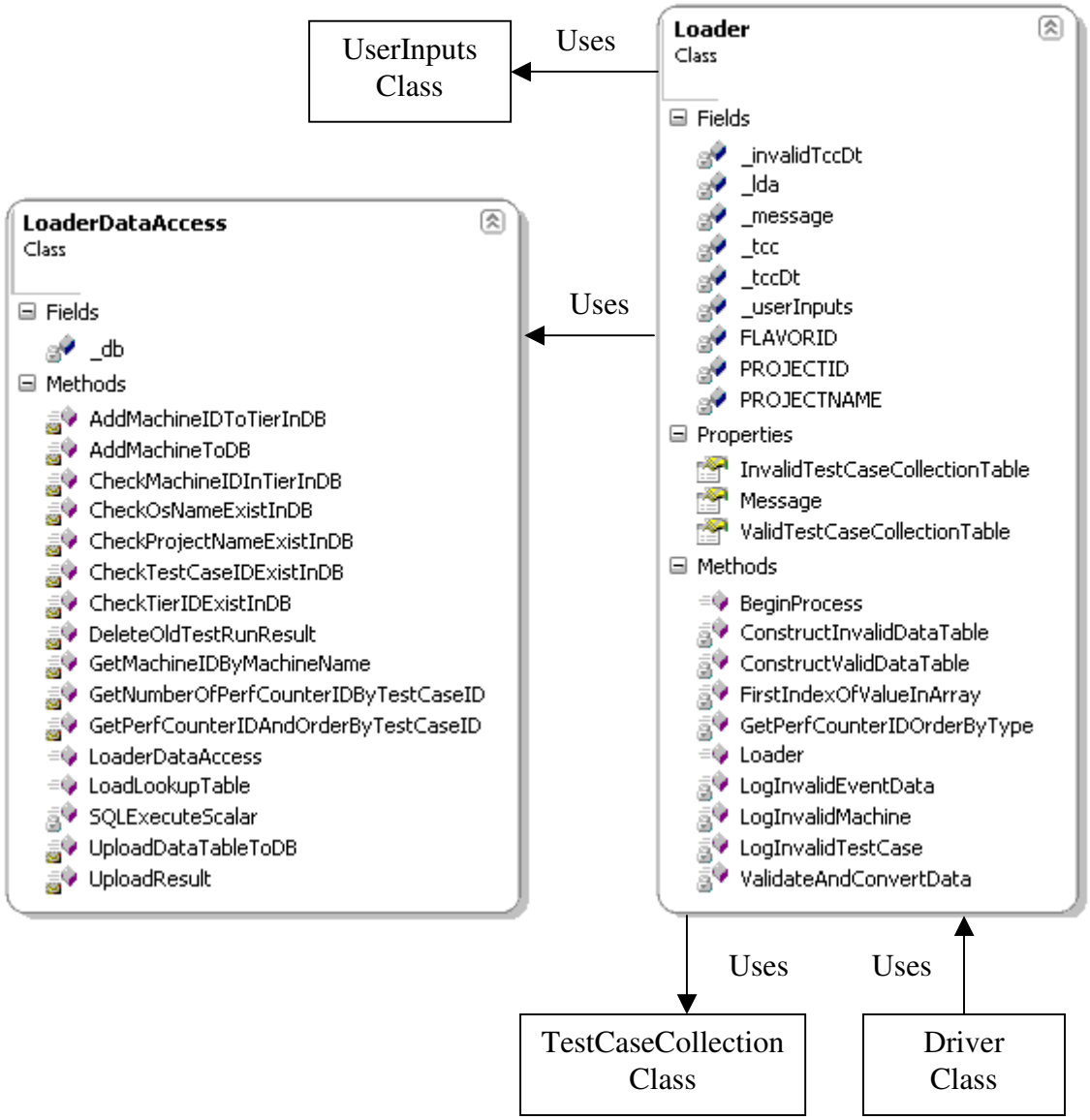


Figure 29. Class-Level Class Diagram: Loader and LoaderDataAccess

4.2 Data Models and Data Access

The system requires two databases for data storage and access:

1. ABench: It is a database that has been used by a variety of performance test teams for their projects and has the following features:

    - It is the backend data storage for ABench website.

- It is the production database that holds all the processed test results.
- In this system, it is the destination for uploading data; it is also used for system initialization and data validation.

2. Helper: It is a database designed and developed for this system only.
    - As the name suggests, it helps the system to do the parsing.
    - It holds the information that cannot be included in the ABench database.

4.2.1 Data Models

Whether the database is designed reasonable and sufficient will have a direct effect on the quality of the application. Data models focuse on what data should be stored in the database. For relational database, the data model is used to design the relational tables.

The database designed for this system is the Helper database, which consists of two tables: AllTestCaseLookUp and AllTestCasePerfCounters. These two tables store the information of lookup table and performance test counters. Table 1 and 2 show the data schema of these two tables. ABench database is briefly discussed in Chapter 1

.

Table 1. AllTestCaseLookUp Database Table

Collumn Name	**Data Type**	**Allow Nulls**	**Primary Key**
ProjectID	smallint	No	No
TestCaseType	char(50)	Yes	No
NumUsers	smallint	Yes	No
FileName	varchar(64)	Yes	No
OrigTestCaseID	varchar(64)	Yes	No
TestCaseID	Int	No	No
TestCaseName	nvarchar(255)	No	No

Table 2. AllTestCasePerfCounters Database Table

Collumn Name	**Data Type**	**Allow Nulls**	**Primary Key**
ProjectID	smallint	No	Yes
TestCaseID	int	No	Yes
TestCaseName	nvarchar(255)	No	No
TestCaseType	char(50)	No	Yes
TestCaseTypeID	int	No	No
TestCaseOwner	char(50)	No	No
TestCaseOwnerID	smallint	No	No
TestCasePriority	smallint	No	No
ScenarioID	Smallint	No	No
PerfCounterID	Smallint	No	Yes
PerfCounterOrder	Smallint	No	No
PerfCounterName	varchar(50)	No	No
PerfCounterUnitID	Smallint	No	No

4.2.2 Data Access

From the data access point of view, the system can be largely divided into the following three layers:.

- Data Presentation Layer: It contains User Interface components
- Business Logic Layer: It contains the parsing and processing modules.
- Data Access Layer: It is used to access and perform operations on database tables.
    1) Connects to the database
    2) Retrieves data from database
    3) Uploads processed data to database

Data Access layer encapsulates database related operations. As a result, it makes it easier to maintain the data manipulation methods without affects other modules.

The data access layer developed for this system includes two classes: ToolDataAccess class and LoaderDataAccess. Please refer to the class diagrams Figure 20 and Figure 28 for their description. These classes make use of Microsoft ADO.NET and stored procedures written with Transact-SQL statements.

Following is a sample method in ToolDataAccess class. The method is used to retrieve the maximum value of a field in a database table. Inputs are the TableName string and FieldName string. Out put is an integer, or 0 if the result is not found. Sample usage is GetMax (“TestCaseTable”, “TestCaseID”).

```
// Retrieve the Max value of FieldName in TableName
public int GetMax(string TableName, string FieldName)
{
     DbCommand getMax = _db.GetSqlStringCommand("SELECT Max(" +
         FieldName + ") FROM " + TableName);

    object result = _db.ExecuteScalar(getMax);
```

```
        if (result == null || result.ToString() == string.Empty)
        {
            return 0;
        }
        else
        {
            return int.Parse(result.ToString());
        }
    }
```

In this method, "_db" is the database connection. "GetSqlStringCommand" is a method to create a database command from an in-line Transact-SQL query string. "ExecuteScalar" queries the database and returns result to object "result". If "result" is not "null" or empty string, it is parsed to an integer and finally returned.

CHAPTER V

TESTING AND VERIFICATION

A system that cannot be trusted to work correctly has no value. This means that the programs must function correctly and the results that come back are valid and complete. Software verification is the set of activities that ensure that software correctly implements a specific function and meets the customer's requirements.

Testing plays an extremely important role in verification. It should intentionally attempt to find problems, for example things happen when they shouldn't or things don't happen when they should. Testing involves operation of a system under controlled conditions and evaluating the results. The controlled conditions should include both normal and abnormal conditions.

5.1 System Testing

System testing provides evidence that the integration of the sub-systems has not resulted in unexpected behavior and the software meets its functional and non-functional requirements. In this system, each module has been tested first after the coding. After integration, the whole system is tested to ensure each part of it communicates well and functions correctly.

The scenarios tested are:

1. Valid data from user interface:

   The system accepts valid inputs and starts processing.

2. Invalid data from user interface:

The system gives error message for the invalid input, processing is not started. For example, if we enter “c:\NoSuchFolder” in the TestResultsFolder textbox and then click on Select Files button, the system gives the following error message (Figure 32):

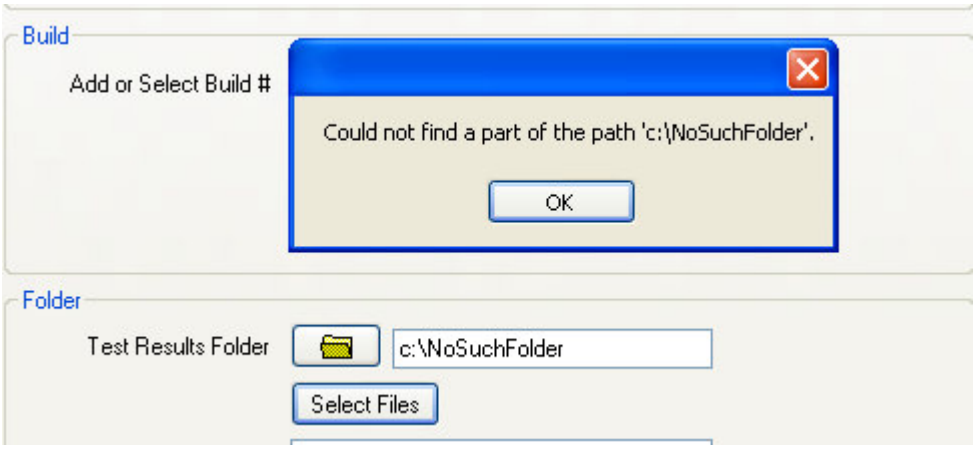


Figure 30. Error Message for an Invalid User Input

3. Valid database settings

   The system starts processing.

4. Invalid database settings, including connection failure, wrong database server name, wrong database credential, etc.

   The system gives error message, processing is not started.

5. Good test results file settings, including correct folder structure, correct naming convention and file format.

   The system processes files and gives correct results.

   An example will be given in next section.

6. Bad test results file settings

   The system processes files and displays information to user.

For example, if there's a piece of invalid test data in the XML file, the system displays the following table (Figure 33):

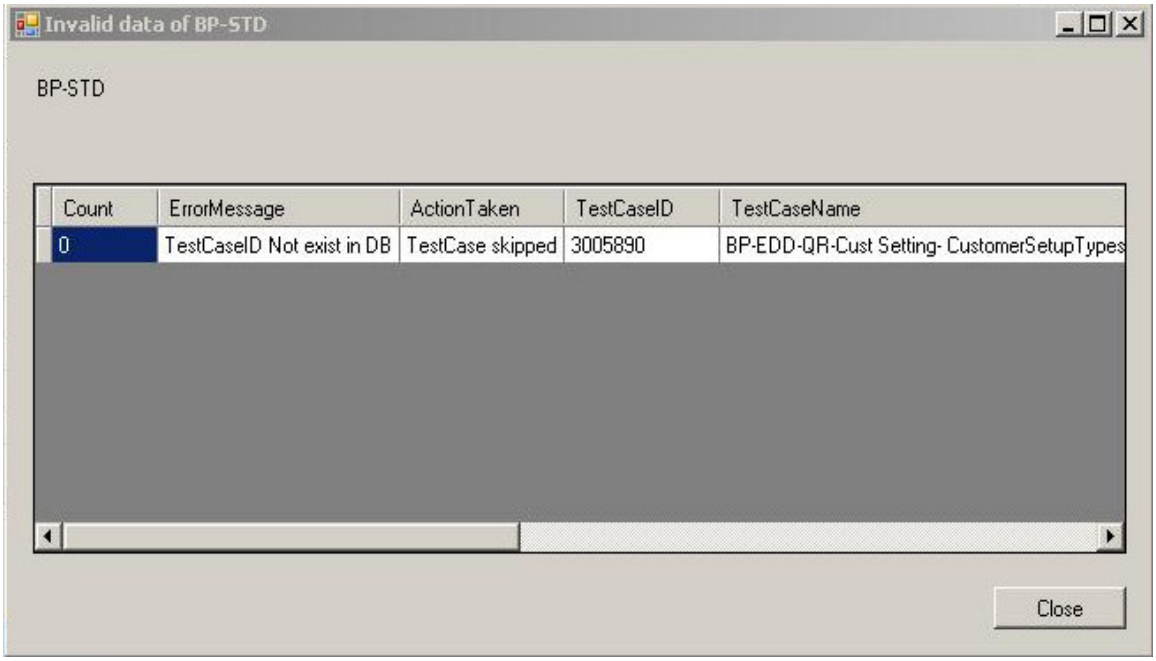


Figure 31. Table Display for an Invalid Test Data

5.2 Acceptance Testing

Acceptance testing provides evidence that the system works with real world data. The system is tested extensively using real test files, including both XML and TXT files. The following example gives a description of the system environments, data used and the results obtained.

1. System environments: They include:
    - Windows XP Professional Operating system
    - .NET framework 2.0
    - Intel 1.66Ghz CPU
    - 1.0G RAM memory

2. Database settings: The settings include:
    - Database server: local machine Sony Vaio Laptop
    - Instance name: (local)\SQLEXPRESS
    - Security: windows authentication
    - Database name: ABench
3. Test files information:
    - Test results folder: C:\Qiang\project_implementation\BPResults
    - Number of test files: 18
    - Type of test files: XML
    - Sample of test file: (Only part of the contents are listed here)

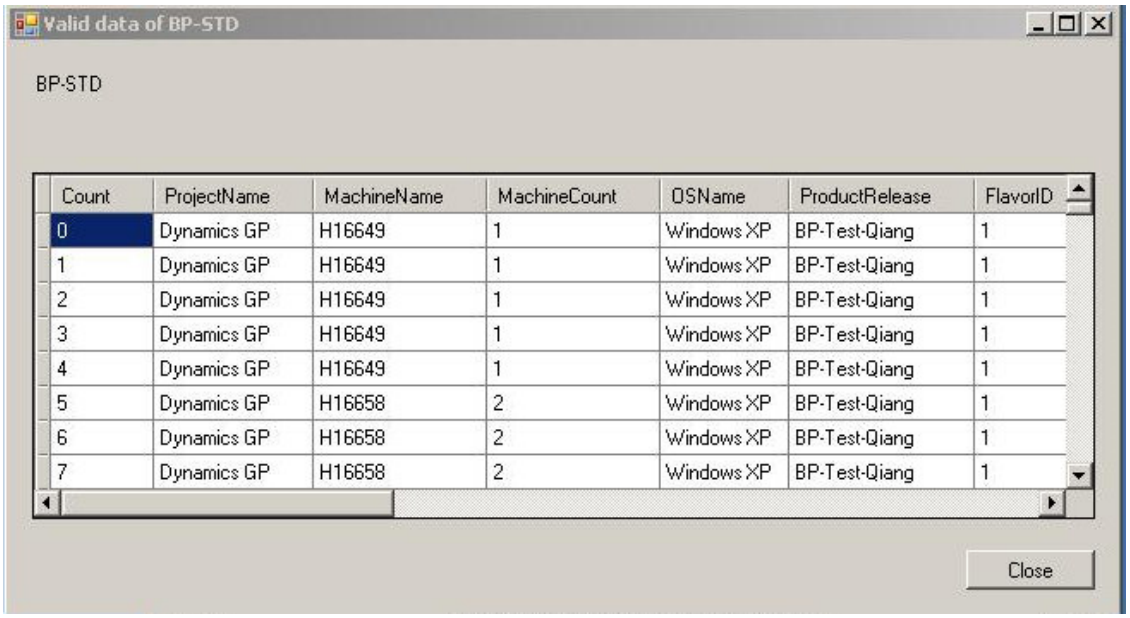
```
<?xml version="1.0" ?>
- <root>
  - <tests>
    - <test>
        <name>HomePageLoad</name>
        <starttime>11/7/2005 6:11:22 PM</starttime>
        <type>performance</type>
        <machine>H16649</machine>
        <os>Win32NT</os>
        <osVersion>5.1.2600.0</osVersion>
        <netFramework>1.1.4322.2032</netFramework>
      - <event>
          <time>6:11:22 PM</time>
          <type>Iteration</type>
          <message>1.0.214.01</message>
          <iteration>1</iteration>
          <data>2266</data>
          <threadid>556</threadid>
        </event>
```

4. Inputs from user interface: The input include:
    - Application type: BP-STD
    - OS: Windows XP

- Tier: BP-Standard
- Bulild #: BP-Test-Qiang
- Expected # of Iterations: 10

5. Results: The results include:
    - Files are parsed and processed. Figure 34 shows the valid data processed.
    - Results are successfully uploaded to ABench database. Figure 35 shows the information. Totally 192 test cases are parsed and 3302 rows are uploaded to the database.
    - ABench website publishes the new updated data for this build number "BP-Test-Qiang", as shown in Figure 36, 37 and 38.
        i. Figure 36 shows the executive summery for the Build # "BP-Test-Qiang". As we can see, the two test cases listed in the table have passed the predefined Goals. For example, the performance value of test case "3000290BP-Admin-UI-Loader-Home-5User" is 2683 milliseconds, which is below the Goal set as 6500 milliseconds.
        ii. Figure 37 shows the trend of the performance by comparing with the previous test results.
        iii. Figure 38 represents the test values of each user for the particular test case.

These tests indicate that the system meets the customer's requirements, both functional and un-functional. It can successfully consolidate and process the test results and publish them in ABench website as expected.



Count	ProjectName	MachineName	MachineCount	OSName	ProductRelease	FlavorID
0	Dynamics GP	H16649	1	Windows XP	BP-Test-Qiang	1
1	Dynamics GP	H16649	1	Windows XP	BP-Test-Qiang	1
2	Dynamics GP	H16649	1	Windows XP	BP-Test-Qiang	1
3	Dynamics GP	H16649	1	Windows XP	BP-Test-Qiang	1
4	Dynamics GP	H16649	1	Windows XP	BP-Test-Qiang	1
5	Dynamics GP	H16658	2	Windows XP	BP-Test-Qiang	1
6	Dynamics GP	H16658	2	Windows XP	BP-Test-Qiang	1
7	Dynamics GP	H16658	2	Windows XP	BP-Test-Qiang	1

Figure 32. Table Display for Valid Test Data

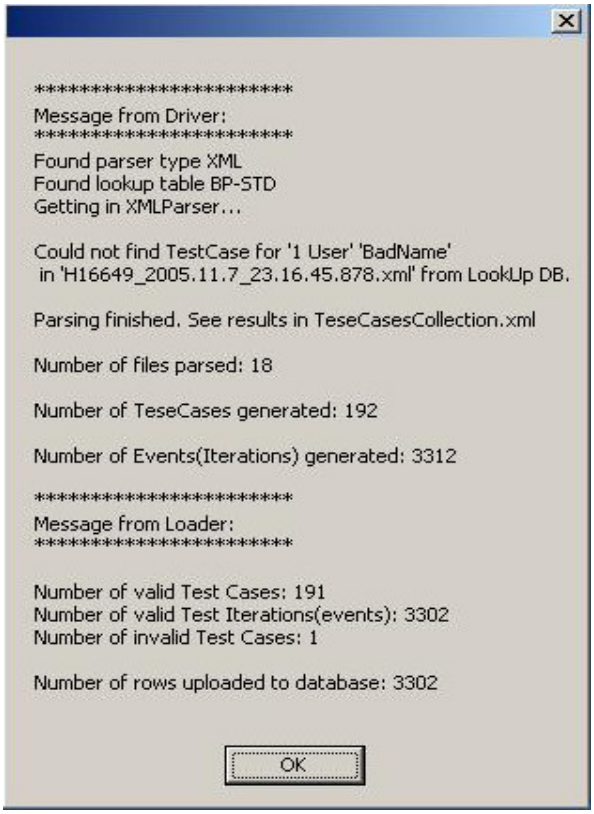

****
Message from Driver:
****
Found parser type XML
Found lookup table BP-STD
Getting in XMLParser...
Could not find TestCase for '1 User' 'BadName'
in 'H16649_2005.11.7_23.16.45.878.xml' from LookUp DB.
Parsing finished. See results in TeseCasesCollection.xml
Number of files parsed: 18
Number of TeseCases generated: 192
Number of Events(Iterations) generated: 3312
****
Message from Loader:
****
Number of valid Test Cases: 191
Number of valid Test Iterations(events): 3302
Number of invalid Test Cases: 1
Number of rows uploaded to database: 3302
OK

Figure 33. Message Box After Processing

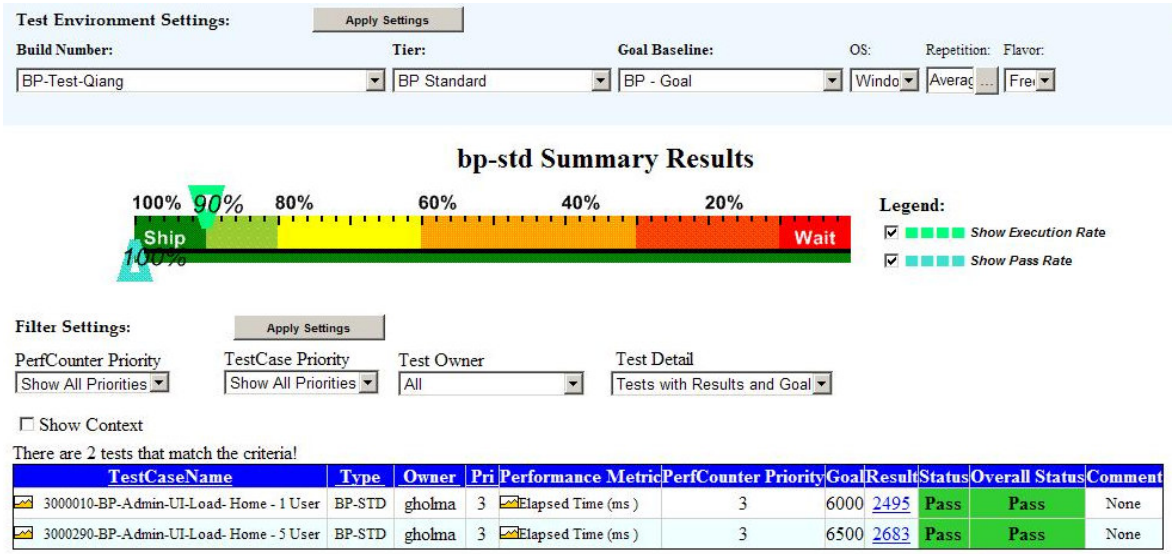


Figure 34. A Screenshot of ABench Webpage

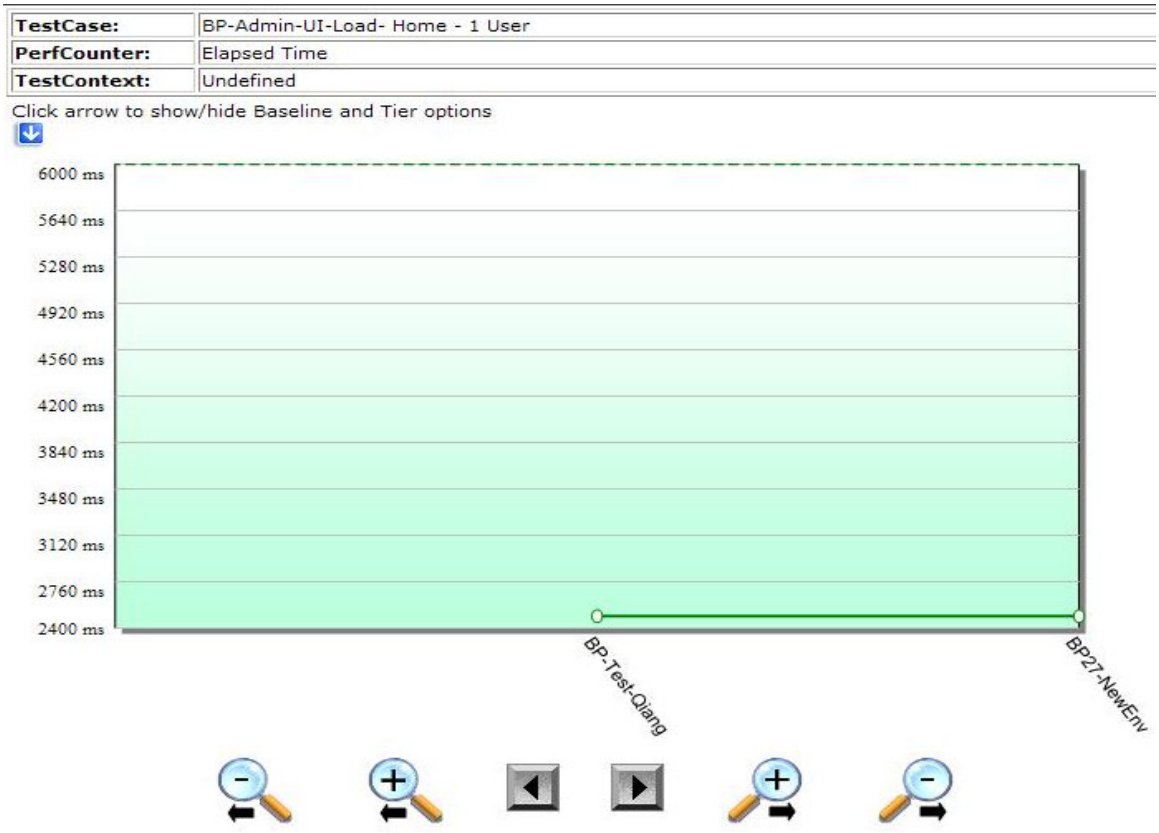


Figure 35. A Screenshot of ABench Webpage

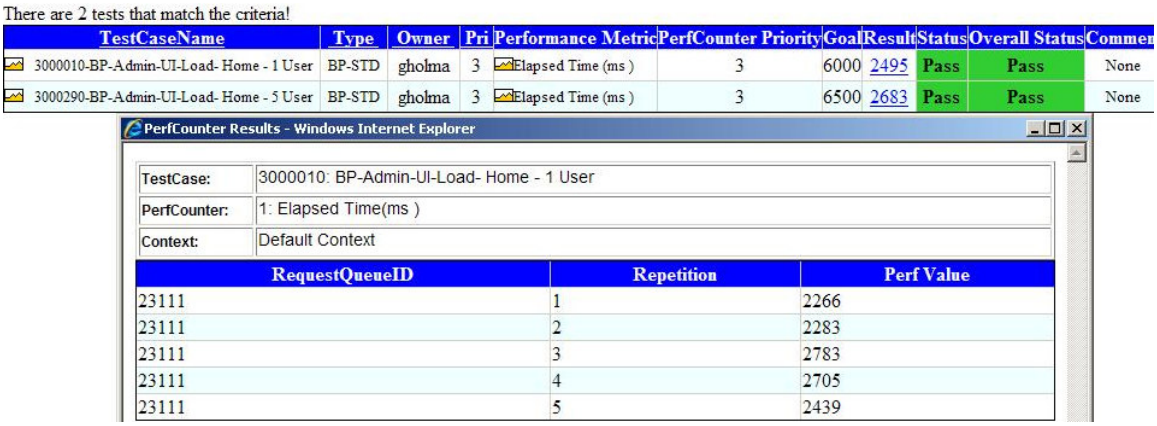


Figure 36. A Screenshot of ABench Webpage

CHAPTER VI

CONCLUSION AND FUTURE WORK

In this project, a data consolidation and importing software was design and developed. It is a database-driven, multi-tier Windows application using C# and .NET programming. The project is a part of the efforts of publishing the performance test results of different applications to ABench web reporting system. The main functionalities of this system are

4. Parse XML results and TXT results according to the application types and predefined configurations.
5. Process and save the parsed data into the remote ABench SQL database.
6. Process test results of other applications that use similar output format.

Requirements specification, design and implementation details are included in this report. Many design/programming features are used to develop a generic tool such as dynamic instantiation. After the implementation is completed, the system was tested by real test files and gave correct results as expected. As a conclusion, it solves the problems of data compatibility and presentation for performance testing data with minimal manual processing.

This project requires knowledge from both of the various performance testing results and the ABench SQL Server database. In addition to software design and development, the following tasks are also critical for this research:

- Design and implement algorithms for processing the raw testing data.

- Establish precise mappings from the test results to the data schemas and models used in ABench database.
- Design and implement a helper database for storing configuration information, lookup tables, etc.
- Implement an ABench website and database on a local machine for system development and testing.

Future work for this project can include:

1. In the current system, users need to modify and save configurations in XML files. A configuration dialog in the user interface can be used to manage configurations.
2. In the current system, the data tables of the Helper database have to be created and populated manually. A function that will initialize these tables from the user interface can be added to the system.
3. The current system can only process test results in TXT and XML formats. It will be more beneficial if test results in other formats can also be processed, such as Excel spreadsheets.

REFERENCES

[1] Martin Fowler, Kendall Scott, *UML Distilled: A Brief Guide to the Standard Object Modeling Language*, second edition Addison-Wesley, 2000

[2] Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli , *Fundamentals of Software Engineering*, second edition, Prentice Hall, 2002

[3] Roger S. Pressman, Roger Pressman, *Software Engineering*, sixth edition, McGraw-Hill Science/Engineering/Math, 2005

[4] Remez Elmasri, Shamkant B. Navathe, *Fundamentals of Database Systems*, third edition, Addison-Wesley, 2000

[5] *Product information for Microsoft Dynamics GP*, Retrieved November 10, 2006, from http://www.microsoft.com/dynamics/gp/product/productoverview.mspx

[6] Christian Nagel, Bill Evjen, Jay Glynn, Morgan Skinner, Karli Watson, Allen Jones, *Professional C# 2005*, third version, Wrox, 2005

[7] Juval Lowy, *Programming .NET Components*, second version, O'Reilly Media, 2005

[8] Cem Kaner, Jack Falk, Hung Q. Nguyen, *Testing Computer Software*, second version, Wiley, 1999

[9] Erik T. Ray, *Learning XML*, second version, O'Reilly Media, 2003

APPENDICES

APPENDIX A

User Manual

This user manual provides instructions of how to setup and use the Data Consolidation and Importing Software. Users should follow the following steps:

1. Check system configuration

   Make sure the computer running this system have the following configurations:

   - Operating system: Windows Server 2003 or Windows XP Professional
   - .NET framework version: 2.0

2. Obtain user permission

   The user must get appropriate credentials to databases:

   - The user has access to ABench and Helper database server
   - The user has permission to upload and delete records on ABench

3. Prepare test results

   The test results must be stored in a consistent agreed upon format, which include folder structure, folder naming convention and file structure.

   - Please refer to “Format of Test Results” in Chapter 3.

4. Install the software

   Copy the whole product folder of “PerfImportTool” to local disk. The folder contains

   - One executable file: “PerfImportTool.exe”
   - Three dynamic link library (DLL) files: “Parser.dll”, “Microsoft.Practices.EnterpriseLibrary.Common.dll” and “Microsoft.Practices.EnterpriseLibrary.Data.dll”
   - Two configuration files: “PerfImportToo.exe.config” and “PerfToolSettings.xml”

5. Setup configuration files

   - Open up “PerfImportToo.exe.config”, find the following statement

```
<connectionStrings>
  <add name="PerfImportToolHelper"
    connectionString="Database=ABench;Server=(local)\SQLE
    XPRESS;Integrated Security=SSPI;"
    providerName="System.Data.SqlClient" />
  <add name="PerfResultsConnection"
    connectionString="Database=Helper;Server=(local)\SQLEX
    PRESS;Integrated Security=SSPI;"
    providerName="System.Data.SqlClient" />
</connectionStrings>
```

   - Change the “Server=(local)\SQLEXPRESS” to your database server instance name.

6. Start the system: click on “PerfImportTool.exe”, the main entry Windows form will display on the screen.

7. Input data using the user interface

   Please refer to “User interface design” in Chapter 3 for detailed explanation of the interface controls.

   - Select an Application Type from “Application” ComboBox, as shown in Figure 39.

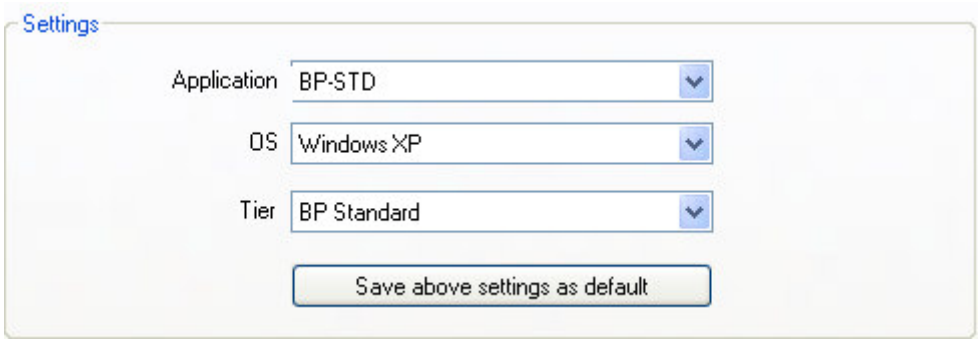


Figure 39. User Interface: Select Application, OS and Tier

- Select an Operating System from “OS” ComboBox, as shown in Figure 39.
- Select an Execution Tier from “Application” ComboBox, as shown in Figure 39.
- If you want to save the above settings, click on “Save above settings as default” Button, as shown in Figure 39.
- Write in the “Add or Select Build #” ComboBox add a new Build Number or select an existing one from the dropdown list, as shown in Figure 40.

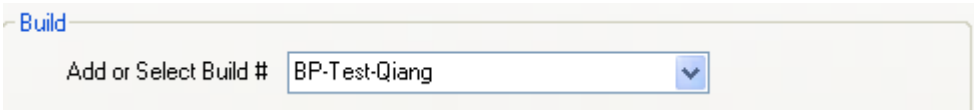


Figure 40. User Interface: Add or Select Build Number

- Check one of the “Actions on existing Build #” RadioButtions accord, as shown in Figure 41.
  i. Click on Append to append new results to the previous test run (default value)
  ii. Click on Overwrite to overwrite the results of previous test run

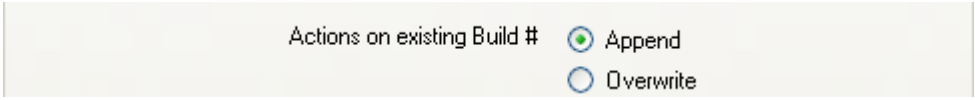


Figure 41. User Interface: Select Action on Existing Build Number

- Click on “Test Results Folder” Button to locate the test results folder or write the full path in “Test Results Folder” TextBox, as shown in Figure 42.
- Click on “Show Files”/”Select Files” Button to populate the below Files ListBox with all eligible files found in the folder, as shown in Figure 42.
- Select files from the Files ListBox to process. Do not select any file is all files are to processed, as shown in Figure 42.

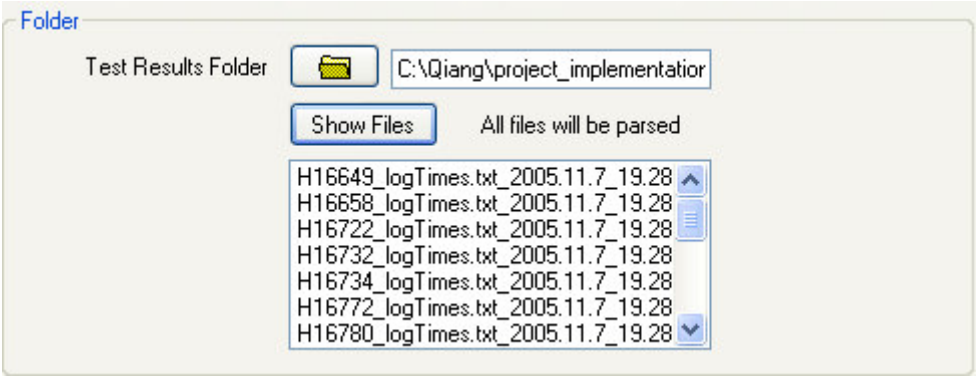


Figure 42. User Interface: Enter Test Results Folder and Select Files

- Click on “Process” Button to start the process, as shown in Figure 43.

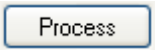


Figure 43. User Interface: Start Process

- After processing, click on “Close” Button to close the software, as shown in Figure 44.

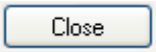


Figure 44. User Interface: Close the Software

APPENDIX B

Source Code

The source code is not printed. It is stored in the accompanied Compact Disk.